TECHNOLOGY DEPARTMENT

Power Generation and POWER PLANT ENGINEERING

For ALL Power Engineers • Steam, Electricity and All Other Power Engineering Services

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MOTORS
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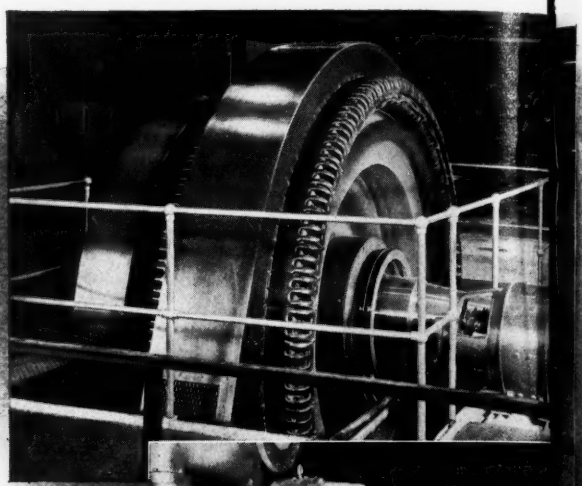

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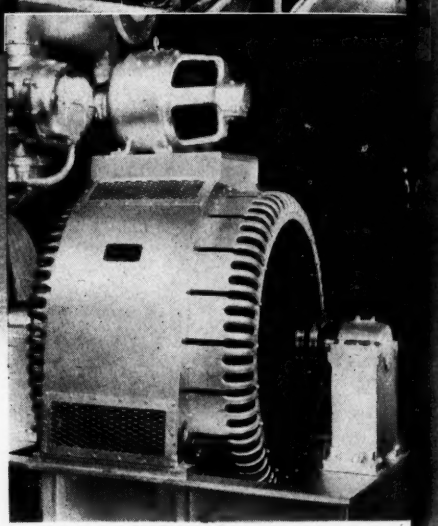
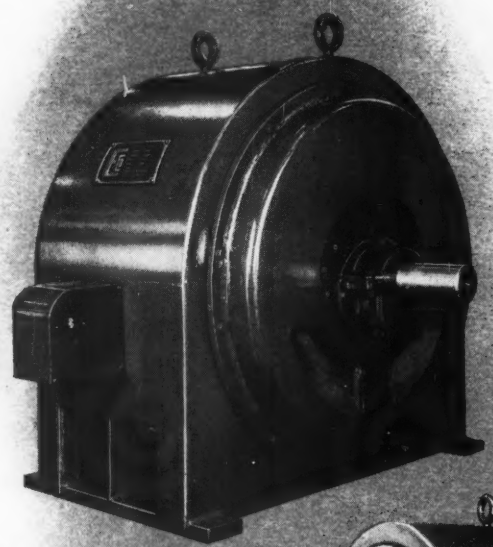
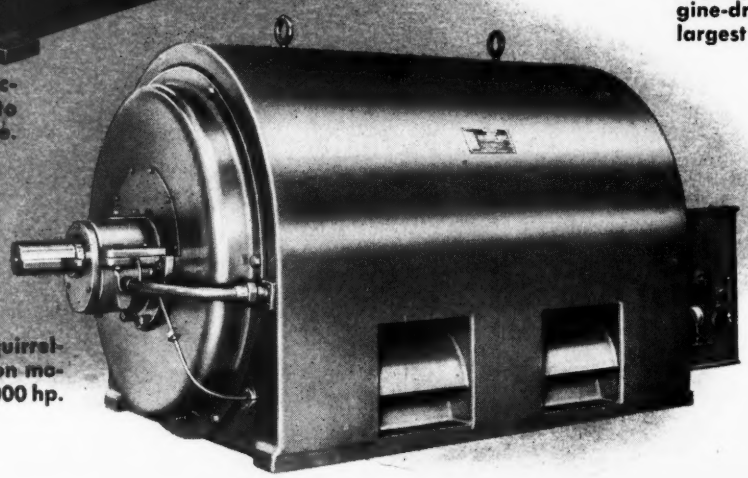


High-speed Diesel or gas-engine-driven generators up to largest size engines available.



Squirrel-cage induction motors 150 to 2000 hp, 4 to 14 pole.



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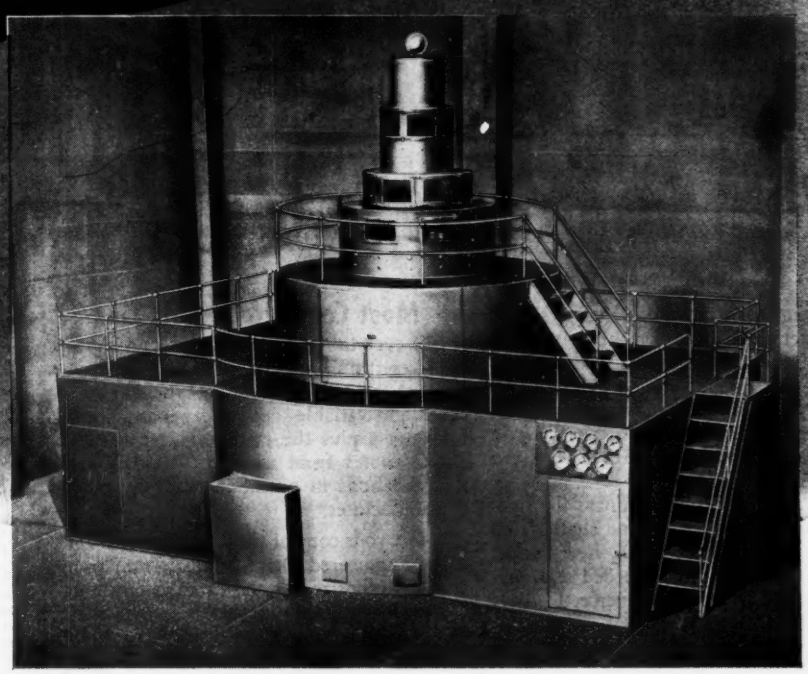

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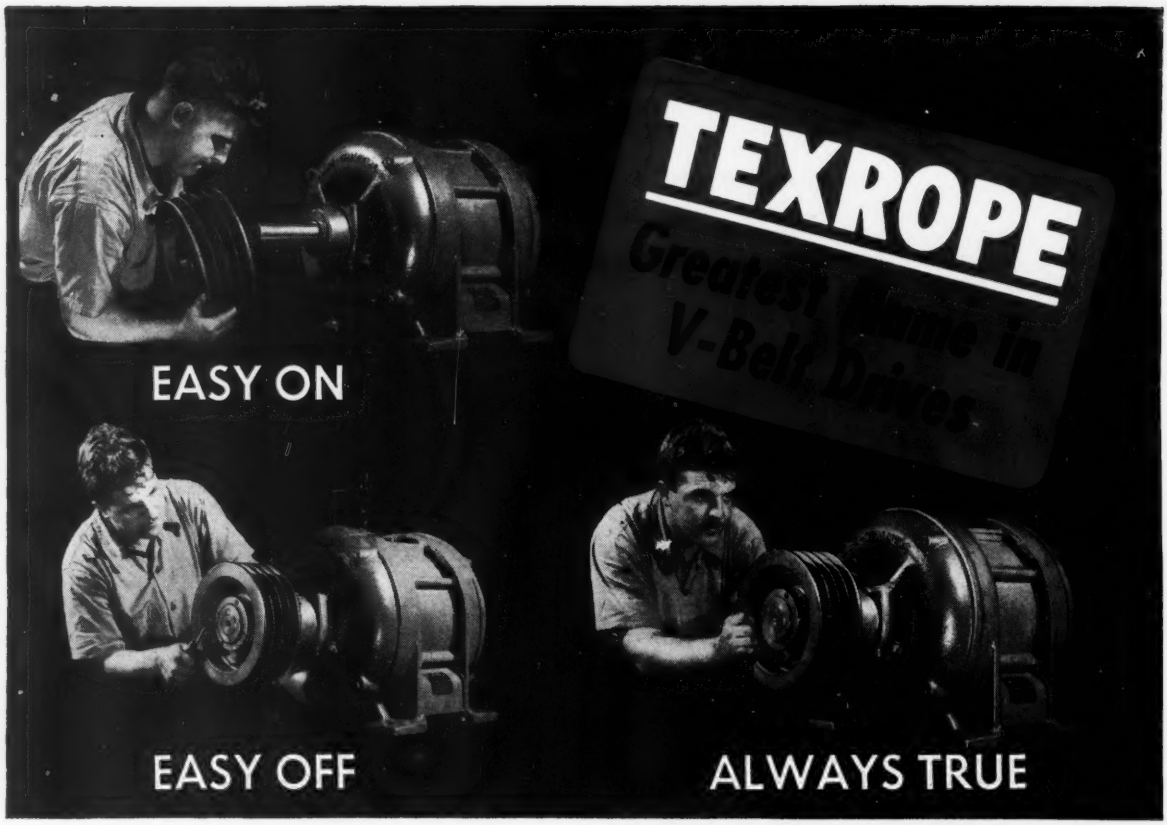

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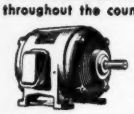

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Power Generation

October 1949

VOLUME 53—NUMBER 10

Notes on This Issue

Industrial Steam on a Grand Scale

At Jones & Laughlin's South Side Works in Pittsburgh, 43 old boilers have been replaced by five up-to-date steam generating units with capacity of over 1,000,000 lb. of steam per hour at 150 psi. The 43 old boilers were put in over the years as the plant grew and this story really puts a dramatic spotlight on 25 years of progress in steam generation.

It is a fine example of an industrial power plant generating practically no electricity but representing every detail of design and equipment of a large steam generating facility. Many industrial plant readers do not use steam on such a grand scale but the information given is extremely useful to anyone planning modernization or a new boiler plant.

Hydraulic Turbine Governors

This article is of primary interest to operators of hydro plants but the principles of hydraulic turbine governors also apply to governors of engines, steam turbines and other prime movers. The governor is the most important mechanical device in a hydro power plant. It controls the speed regulation in accordance with the load of huge hydroelectric generators. Every operator should be thorcughly familiar with the construction and operation of this extremely delicate and complicated mechanism.

Why Blame the Fans?

When your boilers don't behave properly do you automatically cuss the I.D. fan for not being big enough or not operating as guaranteed?

A careful reading of the article by Jack Cassie, the famous "Fan Doctor" may give the fan a better break. With facts and case studies he explains why there may be differences between conditions in your plant and those under which the fan was designed, tested and rated. They are the reasons why fan manufacturers cannot indiscriminately guarantee installed performance.

But the "Doc" is not just establishing alibis. He gives practical and workable ways whereby, at no cost to you, fans can be installed so that performance will be close to that guaranteed under test conditions.

A New Armature Winding Diagram

Every engineer who has had a sudden burn-out in rotating electrical machinery knows how badly he needed stator or armature winding diagrams in replacing damaged coils.

Mr. William T. Taylor who is a world-famous electrical engineer gives in these new diagrams all the data on such windings the operator needs. His earlier articles in POWER GENERATION have dealt with specific types of windings; this article covers the more complicated types used in practice.

Sewaren Again

The first complete description of this "central station of the year" in any magazine was published in July POWER GENERATION. Such an important plant contains features which merit more detailed discussion than is possible in a general description and in this issue we take up the "Centralized Automatic Temperature Monitoring." The centralization of the entire plant control at one point is one of the most important features in the design of Sewaren Station. In the July issue you saw pictures of the central control room. There is much more behind those panels than meets the eye. 640 temperatures in the bearings of equipment and in superheater tubes are recorded at one central point. The definite trend in centralization of control makes this article important to all power plant engineers.

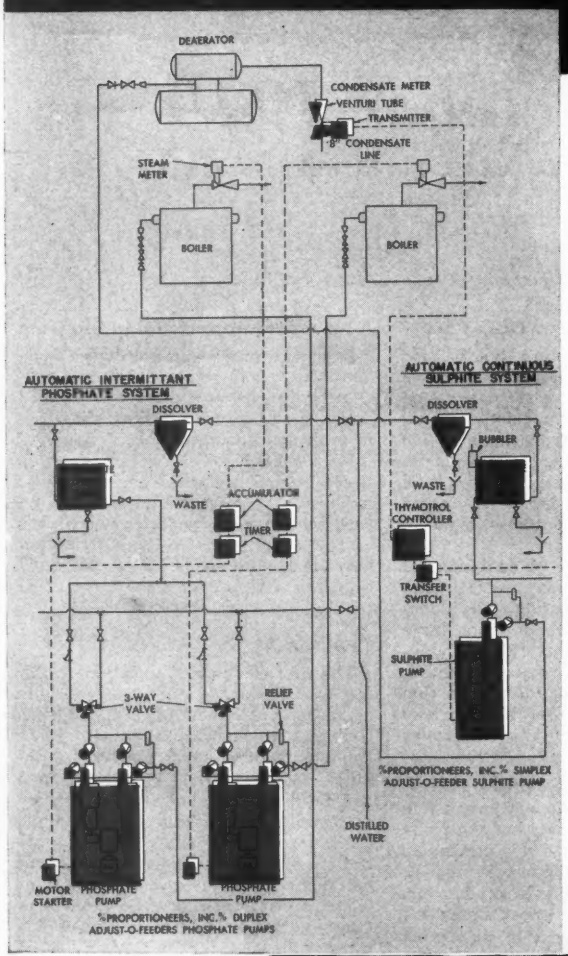
Insulation of Modern Waterwalls

Despite its apparent simplicity the modern furnace wall is a highly complex structure involving a tremendous amount of research and development.

In the old days, when all boilers had solid brick walls with no furnace water cooling, the outside temperature of the furnace walls often ran as high as 350 F. Today, with modern pulverized coal fired furnaces with furnace temperatures of 2700 and 2800 degrees, the outside surfaces of the furnace walls are just comfortably warm.

This article by Mr. Stevens of the Babcock & Wilcox Company tells why the modern walls are so cool; how they are constructed and how much fuel is saved by their use.

Continuous-Automatic



All equipment shown red in photo and flowgram furnished by %Proportioneers, Inc.%

%Proportioneers% sulphite feed pumps in the Redondo Steam Station, in foreground; high pressure duplex phosphate pumps and control panel, in the background.

No. 3 in a series on boiler water conditioning.

BOILER WATER CONDITIONING

%Proportioneers% boiler water treating equipment was selected for the new Redondo Steam Station of Southern California Edison Co. built by Stone & Webster Engineering Corporation in collaboration with Edison engineers. In this, one of the most modern plants in the world, the boilers are treated automatically and in proportion to their service load. The complete %Proportioneers% system makes chemical treatment a routine procedure, reducing operator responsibility. A necessity in large plants, the %Proportioneers% system is also highly desirable in small plants to reduce manpower and give adequate protection.

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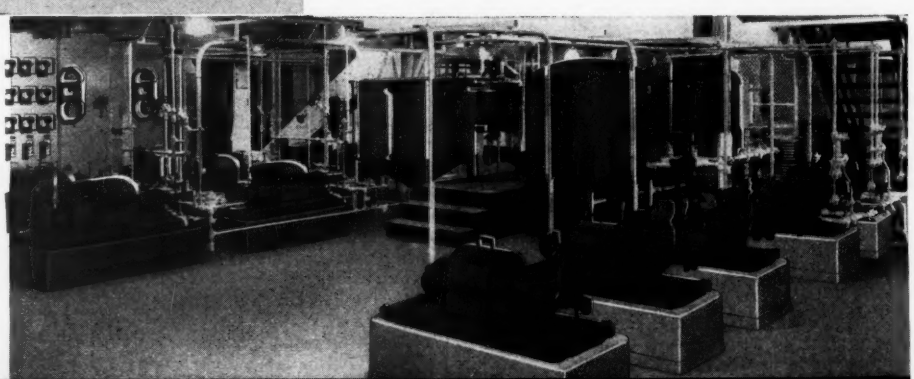

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ENGINEERS' PREVIEW

ORIENTAL MYSTERY—here's one that's causing millions of Moslems to scratch their turbans. Recently a purchasing commission in Karachi invited some Britishers to place contracts in Great Britain for a 450,000-kw power plant to be built in northern Pakistan. British firms announced they would be unable to handle the high-voltage order within the prescribed time so they passed it along to United States organizations for consideration. The Moslems were surprised, to say the least, when they were suddenly notified that Japanese electrical engineers were en route to Pakistan to do the job, with the approval of the State Department and General MacArthur—as a measure of Japanese industrial rehabilitation. Oh, well—it's only a little more complicated than the tensor calculus or the Hamiltonian equations.

★ ★ ★

REVOLUTION on the Skyline may be under way. Here's what might happen to you in the not too distant future. You drive downtown. You turn into what seems to be a big garage. You drive up—or perhaps down—a ramp, and park your car in its accustomed space. You step on an escalator, and ride up to the garden.

Yes, that's where your office building is—in a landscaped garden, up above the busy street. The structure on which it is built covers the whole lot, but only to a height of three stories. That part of the building, except for stores and shops on the street level, is all for parking. Here on the roof of the third story is the garden, with grass and trees and pools, and in the center of it, covering only about an eighth of its area, rises a straight, 20 story shaft of metal and glass—an office building so modern that even the window-washing is done automatically, by squeegees running on tracks around the whole building.

That is the office building of tomorrow as visualized at a recent meeting of the National Association of Building Owners and Managers by Nathaniel A. Owings of the Chicago architectural firm of Skidmore, Owings & Merrill. Not more and bigger skyscrapers but a different kind. Already it is claimed that the forerunners of tomorrow's building are already beginning to appear in such examples as the Universal Pictures Building in New York; the First National Bank Building in Tulsa, Okla., and so on. These are big buildings but of the order of 20 stories or so in height, not the cloudscrapers of the 1920's.

Plenty of air conditioning and modern lighting, a very large proportion of the walls made of glass—the problems of supplying heat and air, power, water and elevator services to such buildings should challenge the imaginations of power engineers.

★ ★ ★

YOU HAVE doubtless noticed the rash of Swiss wristwatches now breaking out on the American market — with special virulence in chain drug stores. Also, there are some rather large orders for electric radio-alarm clocks from Switzerland. General Electric offers us a picture of "Swiss watchmakers being awakened by American-made clocks, to get an early start making Swiss watches which, when finished, they may sell to Americans in order to earn money to buy American-made clocks to give to their Swiss watchmaker friends."

AS LONG AS we have a competitive economy—and to our mind we are going to have one for a long time to come even if we do mix a little of the "welfare state" in with it—the competition between the fuels is in our view a very healthy manifestation. Coal is, of course, the basic fuel of the country and will be for a very long time. But power engineers should study carefully the various factors involved in all our fuel supplies and, so far as they are able, take advantage of changes in those factors. Gas from Texas will soon fry eggs on the housewife's stove in Staten Island, if it is not already doing so. The oil cauldron again bubbles over. The fires of discontent in the industry, according to the AP, are fed by those who produce oil here and see their production being cut back, and those who import oil from overseas. Sometimes the same American companies do both and that brings the battle right into the family, but at least there seems to be plenty of oil around for domestic and power purposes. The pot is boiling too under the field of synthetic fuels and by-products from natural gas and coal. And behind it all you hear the tremendous measured tread of atomic power still 20 years away (See our companion magazine *ATOMICS*). Instead of complaining about the fuel situation our engineers would do well to study it closely and get themselves into a position to take advantage in their own particular power plants of the changes that are sure to come. In many cases they will be forced to do this whether they like it or not. And then there is hydro . . . also shale oil.

★ ★ ★

NEW TYPE of coal-burning, steam-turbine, electric drive locomotive, to be built by Baldwin Locomotive Works, in collaboration with Westinghouse Electric Corp. and The Babcock and Wilcox Co., has recently been ordered by the Norfolk and Western Railway Co. The new locomotive is rated at 4500 hp and designed for freight service. In this unit steam will be generated in a 600 psi water tube boiler burning coal and supplying steam to an impulse type turbine driving a 2-unit, direct-current electric generator through a set of single reduction gearing. Power from this generator will drive the locomotive through traction motors mounted on each axle.

★ ★ ★

WE GENERALLY take it for granted that, when we buy an electric lamp, it will fit in the socket and will give the amount of light and service that we need. But we sometimes do not realize that this satisfactory condition is not being achieved without considerable work behind the scenes. Just what that work involves, on the part of the committees working under the procedure of the American Standards Association, is told in recent interesting articles in ***Standardization***, the news magazine of the American Standards Association. Those interested can obtain copies of the article from the Association at 70 East 45th Street, New York 17.

★ ★ ★

HIGHLIGHT of Crucible Steel Co. of America's new steel plant at Pittsburgh is a hot rolling mill with its own auxiliary gas-fired furnaces to keep steel hot during rolling operations, in which slabs of steel are reduced to sheets or strips. The mill has working rolls 66 in. wide and a speed of 1200 fpm.

TWO ENGINEERING college courses recently announced by the Graduate Division of New York University College of Engineering reflect study of engineering of the present and future rather than of the past. One new course in Principles of Research Procedure will be offered during the fall term, designed for students preparing for advance degrees or a research career. The course will give a general background and a detailed treatment of various research techniques. It will be given in conjunction with a course in management of research and development.

The second new course called Nuclear Energy Enginering will also be given during the 1949-1950 academic year beginning in September. The first term will cover introduction to the field of nuclear energy from an engineering point of view, introduction to nuclear physics, chemistry of heavy elements and nuclear fuels, the fission process, pile theory, control and operation of a pile and so on. During the second term separation processes and enrichment, thermal diffusion, gaseous diffusion, concentration by electromagnetic methods, and related subjects will be given.

★ ★ ★

SPEAKING on the development of the atomic bomb in August 1945, Winston Churchill said:

"It is by God's mercy American and British, instead of German scientists, discovered the secret of atomic power long mercifully witheld from man." Again, in the opening paragraph of Mr. Churchill's memorable address at the recent mid-century convocation at the Massachusetts Institute of Technology, he paid a tribute to the American engineer when he said:

"We have suffered in Great Britain by the lack of colleges of university rank in which engineering and allied subjects are taught. Industrial production depends on technology and it is because the Americans, like the pre-war Germans, have realized this and created institutions for the advanced training of large numbers of high-grade engineers, to translate the advances of pure science into industrial technique—it is for this reason that their output per head and consequent standard of life are so high."

Coming from Mr. Churchill, this is an excellent tribute to the effectiveness of our colleges and universities. Mr. Churchill has performed a distinct service in providing us with an outside, authoritative estimate of the contribution of American engineers. The engineering profession in this country can be proud of this evaluation.

★ ★ ★

IF YOU DON'T already receive it, try to get yourself on the mailing list to receive the circular announcing selected United States Government Publications issued semi-monthly by the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Here you will find publications listed on every conceivable subject ranging from administration of vocational education through easy-to-build-kitchen cabinets and Light List, Atlantic and Gulf Coasts through Survival in the Air Age and an Introduction to the Ceramics of Tres Zapotes, Veracruz, Mexico. Engineers, we find, do not as a group realize the amount and type of information that all citizens are paying their government to collect for them on every conceivable subject. A great deal of it is of the most practical, usable nature, and you ought to sample it some time. For instance, we notice a book on Use of Tools prepared for the Navy. Maybe it's something that a maintenance man could use. We'll let you know.

DEPARTMENT OF COMPLETELY USELESS INFORMATION:—If you are one of the lovers of bock beer, do you happen to know how it got its name?

Well, the Near Editor of the *Houghton Line* tells us in his June 1949 issue that he had wondered not only about the name but about how bock beer is made. The latter, he says, is explained in a *Members' Bulletin* of the United States Brewing Foundation, Inc., if you can get a copy of it.

As to the name, the story is that bock beer was first produced in Einbeck, Germany, in the year 1249. A glass or stein of the brew was called "ein Einbeck," which was gradually shortened to "ein Beck." This in turn became corrupted into "ein Bock;" and Bock is the German word for "goat." That is why the symbol of the long-whiskered goat is generally used in advertising bock beer.

★ ★ ★

MORE GAS pipeline news. Portland Pipe Line Corp., which operates a 12-in. line between Portland, Maine and Montreal is planning to add a 22-in. line, 236-miles long, alongside the present pipe. It is expected to be finished in November, and increase the capacity to about 140,000 barrels a day from the present 67,000. Texas Gas Transmission Corp. is buying and building underground storage facilities to expand the amount of gas to be withdrawn for wintertime use. It plans to build seven storage fields with a capacity of 21,500,000,000 cu ft at a maximum daily delivery of 77,000,000 cu ft.

★ ★ ★

STILL MORE about pipelines — only this time it's television. Piped radio and television may become a reality if a system recently patented by Keith L. Bell can be put into use. According to Dr. Frank Thone, *Science Service* staff writer, Mr. Bell's system calls for the use of actual pipes buried in the ground as carriers for the radio-frequency energy for "piping" programs. He suggests, in particular, utilizing the already existing city water and gas pipe networks.

Buried pipes, however, are not necessary. Above ground metallic structures such as railroad rails and power transmission lines can also be used. Since these run across the country for many miles, the present horizon limits on video frequencies will no longer apply.

★ ★ ★

WORK IS UNDER WAY, we understand, on the controversial New Johnsonville steam plant of the TVA, for which the first $2,500,000 of the $54,000,000 appropriation has been approved. It is expected that the first turbine generator at the plant will begin operation in January 1952. This, we understand from a recent United Press dispatch, will help relieve a predicted power shortage during the winter of 1951.

★ ★ ★

"CAN'T GET AWAY from our wives even at sea!" a Gloucester fisherman told us last week. "They made us install ship-to-shore phones in our boats so they can check up on us in bad weather. They don't enjoy the worrying, like their grandmothers did." However, this year no Gloucester fishermen were lost at sea.

★ ★ ★

METHODS for developing training programs for lubrication engineers were discussed on September 29 by Charles L. Pope, Eastman Kodak Co. engineer, and first president of the newly-organized American Society of Lubrication Engineers, at the opening session of a two-day conference on industrial lubrication at Kingsport, Tenn.

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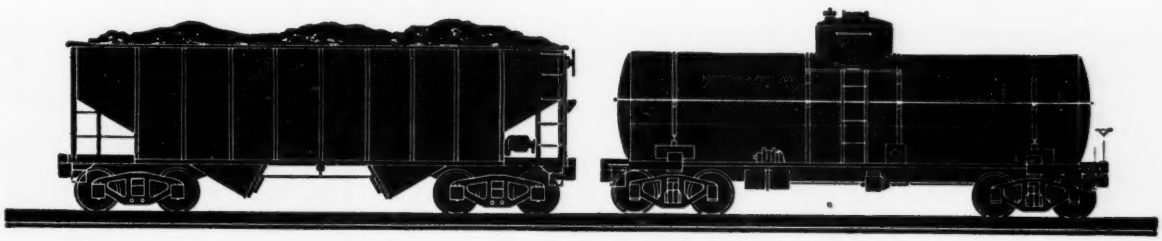

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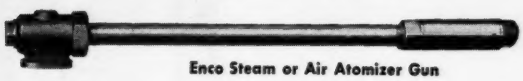
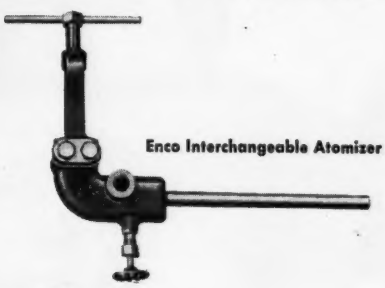


Enco Steam or Air Atomizer Gun



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With Stoker or Hand Fired Units, this same combination can be made for partial or full loads, either for temporary or permanent application. Complete information on installations of this type will be sent on request.

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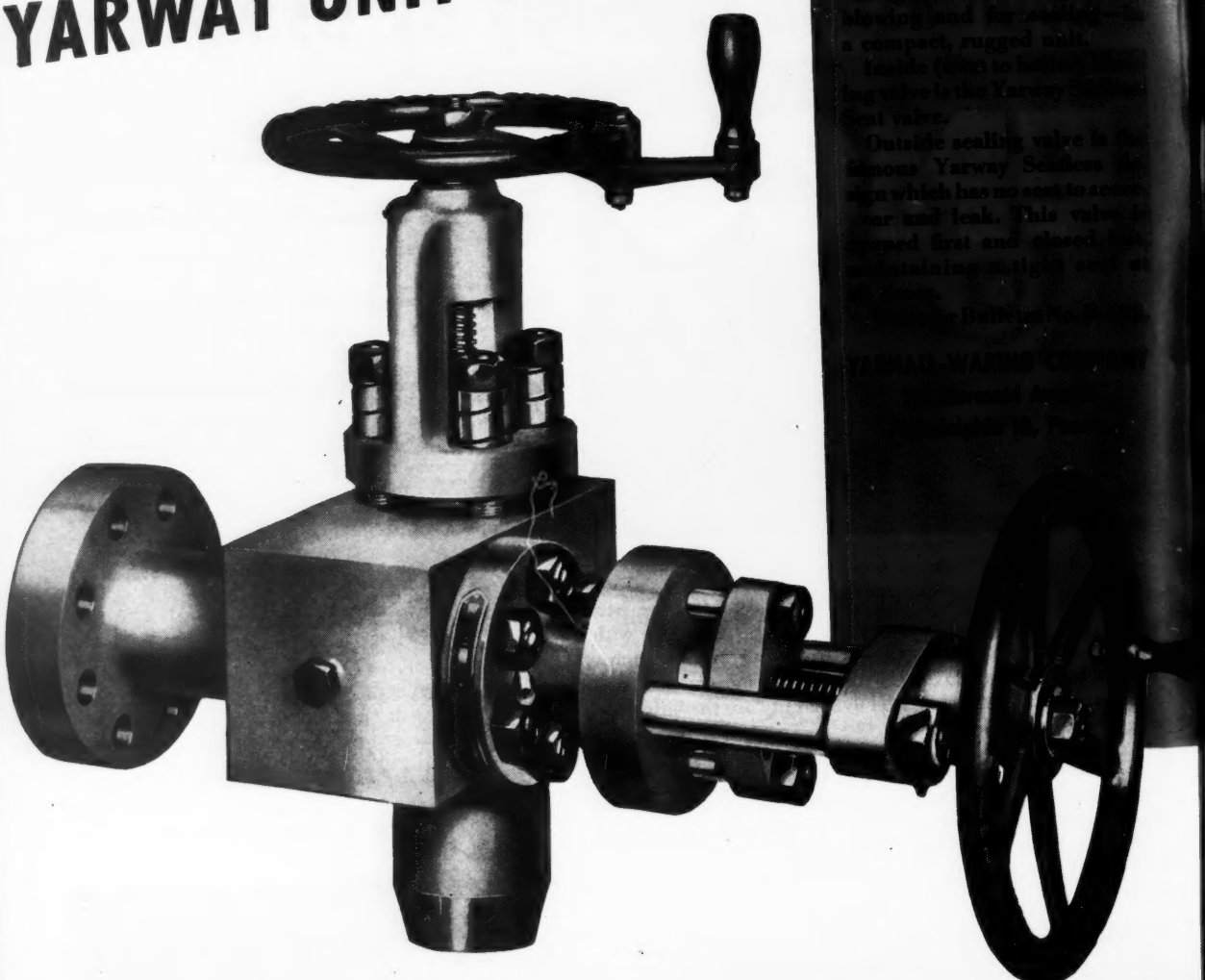
YARWAY UNIT TANDEMS

Years of service in the high pressure plants of leading Utilities and Industrials have proved the soundness of design and metallurgy of Yarway Unit Tandems.

Yarway Unit Tandems are built for pressures up to 2500 psi. Combining a Stellite-Seat and a Seatless valve in a single one-piece forged steel body, this tandem provides the advantages of both designs for blowing and for sealing—in a compact, rugged unit.

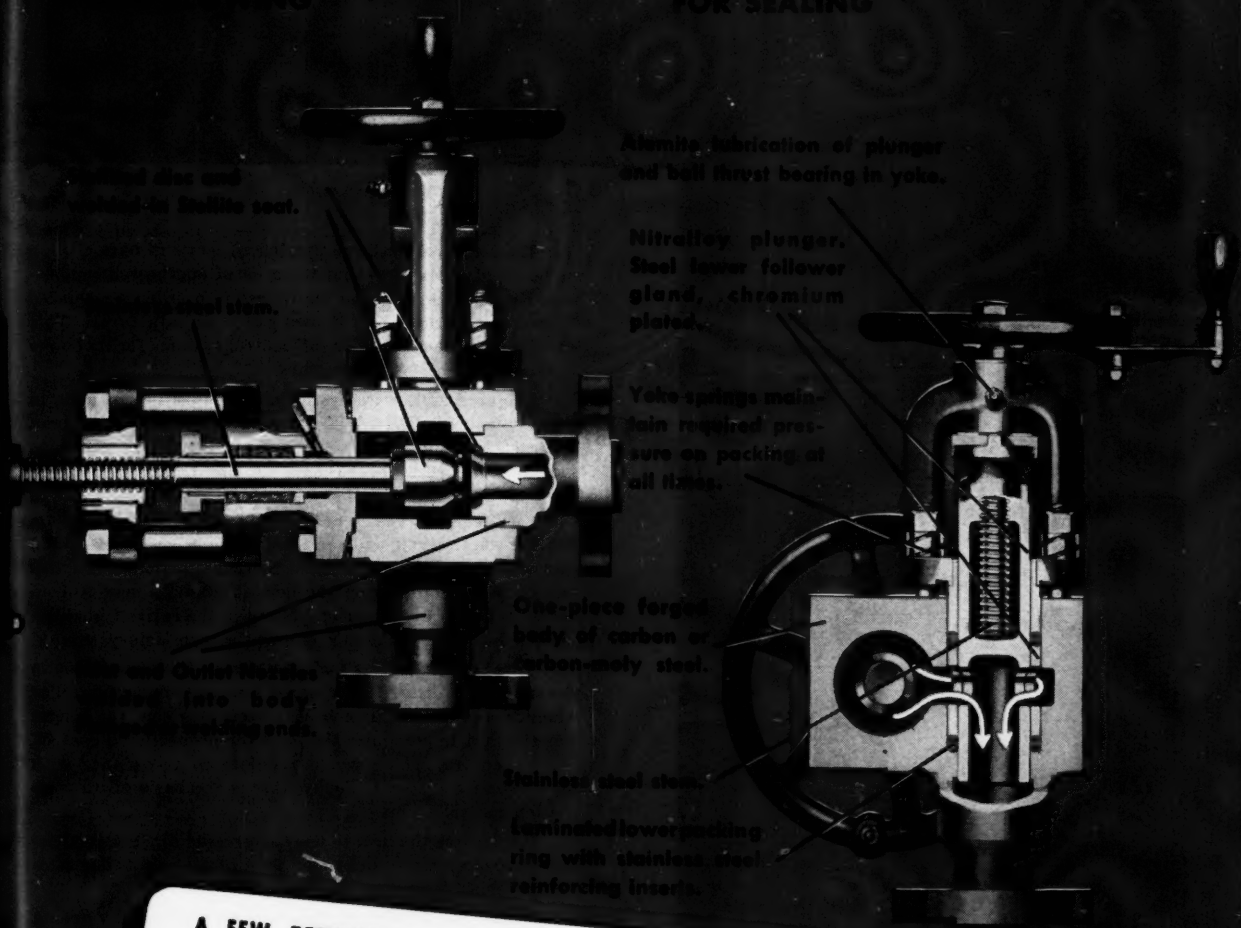
Inside (first to handle) sealing valve is the Yarway Stellite-Seat valve.

Outside sealing valve is the famous Yarway Seatless design which has no seat to score, wear and leak. This valve is opened first and closed last, maintaining a tight seat at all times.



YARWAY B

PRESSURES


SEATLESS VALVE
FOR SEALING
Alemite lubrication of plunger and ball thrust bearing in yoke.
Nitralloy plunger. Steel lower follower gland, chromium plated.
Yoke springs maintain required pressure on packing at all times.
One-piece forged body of carbon or carbon-moly steel.
Stainless steel stem.
Laminated lower packing ring with stainless steel reinforcing inserts.

A FEW REPRESENTATIVE USERS OF HIGH PRESSURE YARWAY BLOW-OFF VALVES

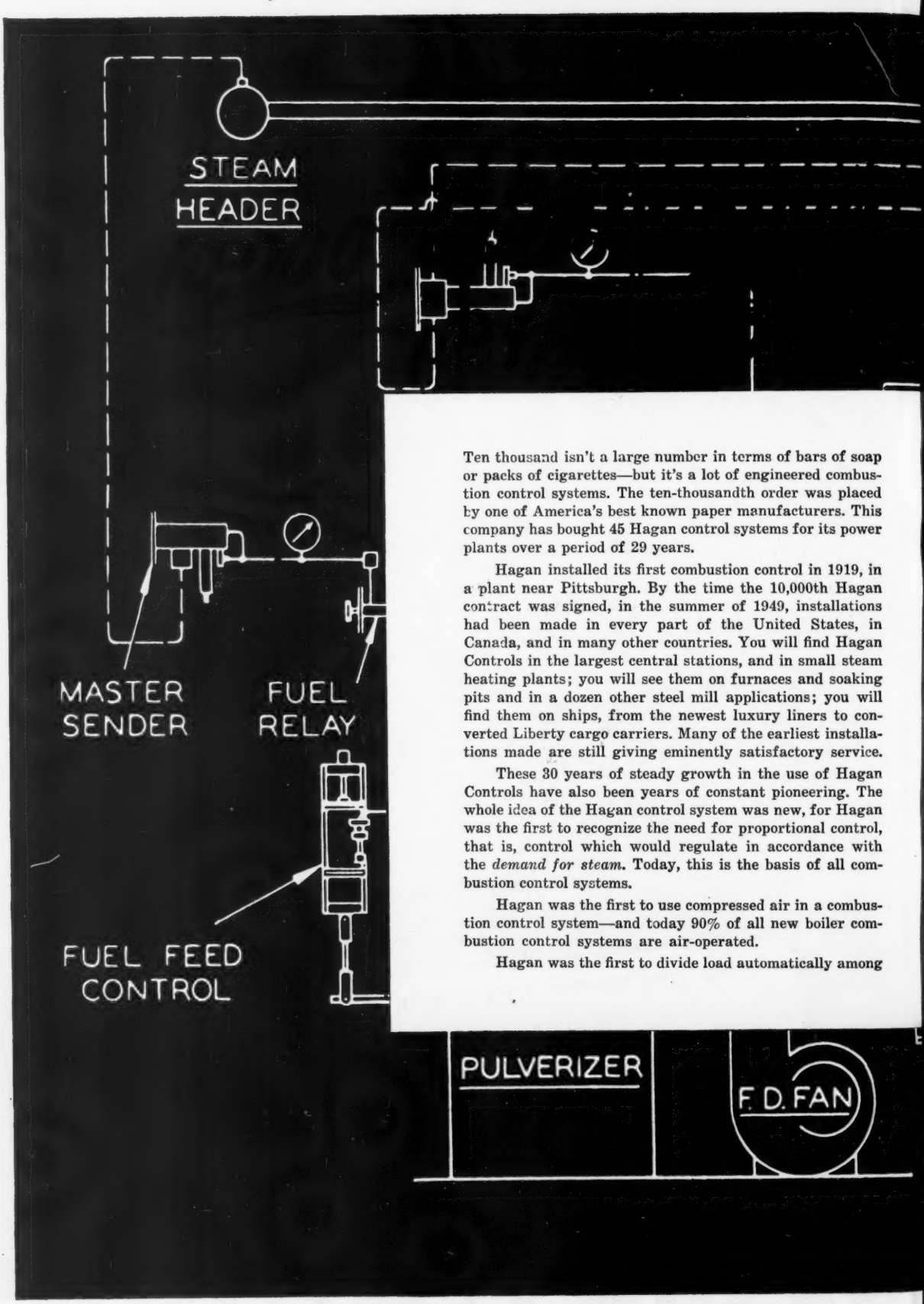
• UTILITIES •

Philadelphia Electric Co.
Boston Edison Co.
Pacific Gas & Electric Co.
Pennsylvania Power & Light Co
Georgia Power Co.
Cleveland Elec. Illuminating Co.
Connecticut Light & Power Co.
Indiana-Michigan Power Co.

• INDUSTRIAL PLANTS •

Celanese Corp.
R. J. Reynolds Tobacco Co.
Eastman Kodak Co.
Armour & Co.
American Viscose Co.
Lever Bros. Co.
Armstrong Cork Co.
Bethlehem Steel Co.

YBLOW-OFF VALVES



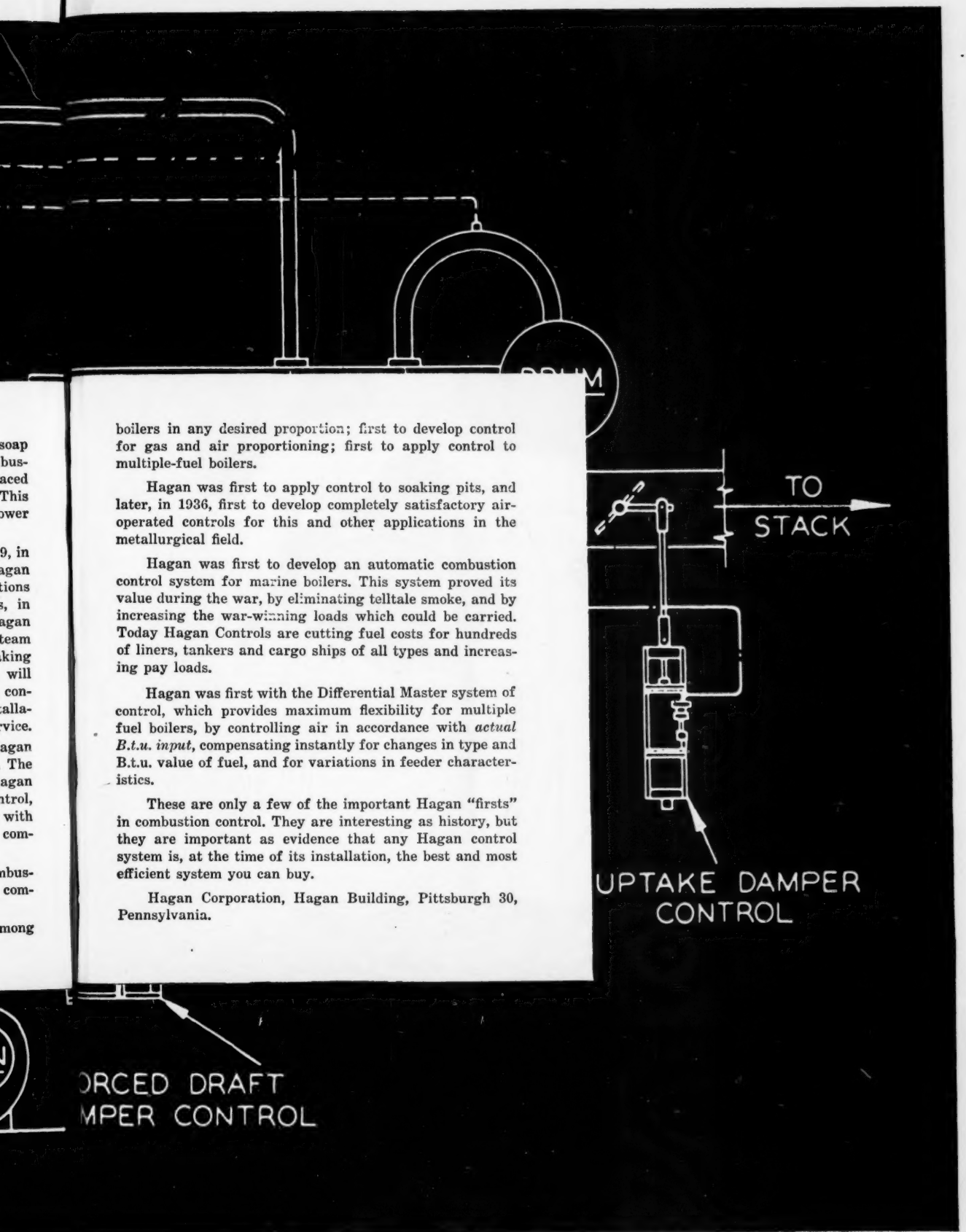
Ten thousand isn't a large number in terms of bars of soap or packs of cigarettes—but it's a lot of engineered combustion control systems. The ten-thousandth order was placed by one of America's best known paper manufacturers. This company has bought 45 Hagan control systems for its power plants over a period of 29 years.

Hagan installed its first combustion control in 1919, in a plant near Pittsburgh. By the time the 10,000th Hagan contract was signed, in the summer of 1949, installations had been made in every part of the United States, in Canada, and in many other countries. You will find Hagan Controls in the largest central stations, and in small steam heating plants; you will see them on furnaces and soaking pits and in a dozen other steel mill applications; you will find them on ships, from the newest luxury liners to converted Liberty cargo carriers. Many of the earliest installations made are still giving eminently satisfactory service.

These 30 years of steady growth in the use of Hagan Controls have also been years of constant pioneering. The whole idea of the Hagan control system was new, for Hagan was the first to recognize the need for proportional control, that is, control which would regulate in accordance with the *demand for steam.* Today, this is the basis of all combustion control systems.

Hagan was the first to use compressed air in a combustion control system—and today 90% of all new boiler combustion control systems are air-operated.

Hagan was the first to divide load automatically among



boilers in any desired proportion; first to develop control for gas and air proportioning; first to apply control to multiple-fuel boilers.

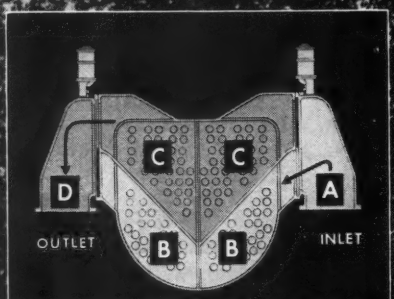
Hagan was first to apply control to soaking pits, and later, in 1936, first to develop completely satisfactory air-operated controls for this and other applications in the metallurgical field.

Hagan was first to develop an automatic combustion control system for marine boilers. This system proved its value during the war, by eliminating telltale smoke, and by increasing the war-winning loads which could be carried. Today Hagan Controls are cutting fuel costs for hundreds of liners, tankers and cargo ships of all types and increasing pay loads.

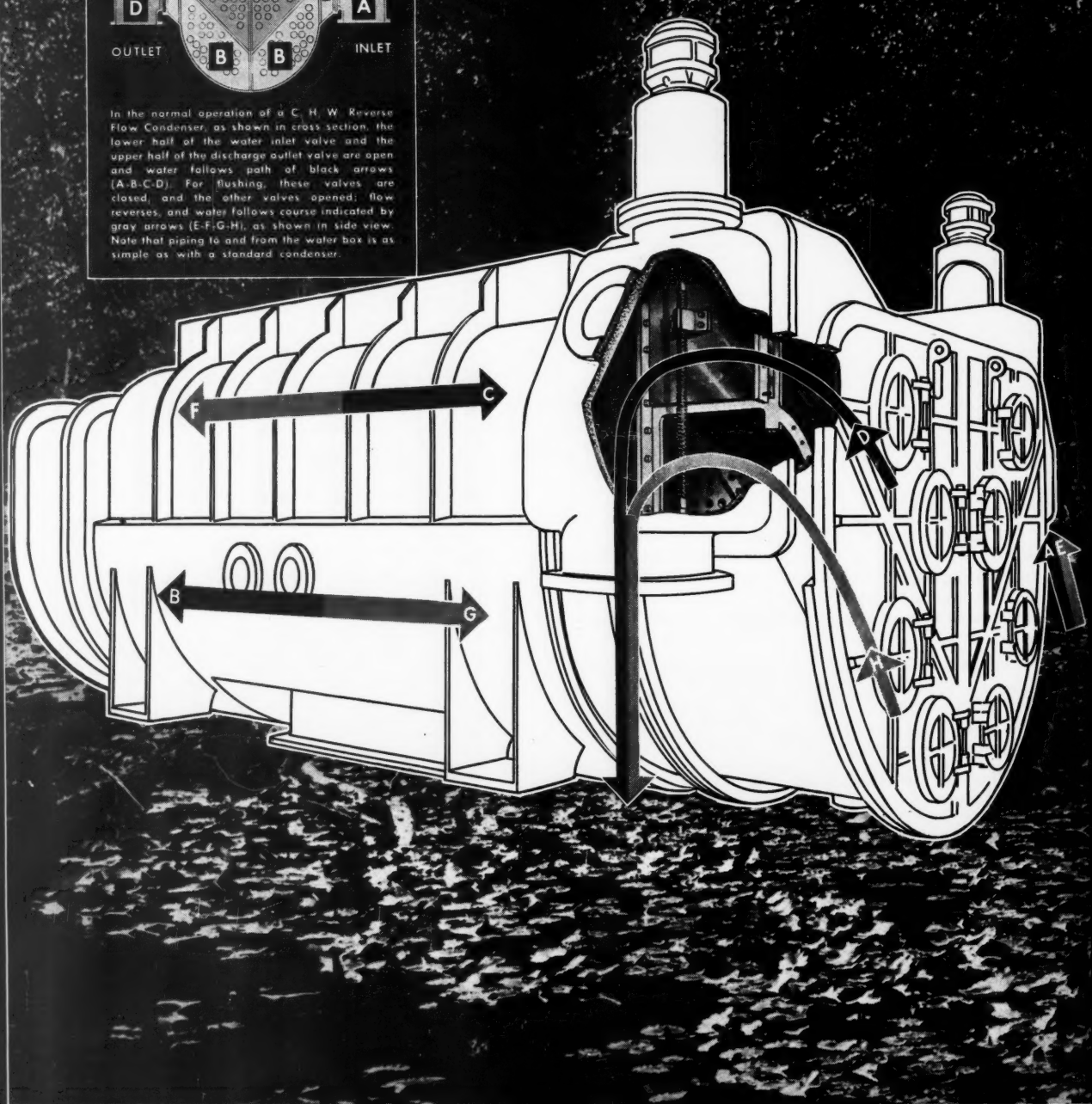
Hagan was first with the Differential Master system of control, which provides maximum flexibility for multiple fuel boilers, by controlling air in accordance with *actual B.t.u. input*, compensating instantly for changes in type and B.t.u. value of fuel, and for variations in feeder characteristics.

These are only a few of the important Hagan "firsts" in combustion control. They are interesting as history, but they are important as evidence that any Hagan control system is, at the time of its installation, the best and most efficient system you can buy.

Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.



In the normal operation of a C. H. W. Reverse Flow Condenser, as shown in cross section, the lower half of the water inlet valve and the upper half of the discharge outlet valve are open and water follows path of black arrows (A-B-C-D). For flushing, these valves are closed, and the other valves opened; flow reverses, and water follows course indicated by gray arrows (E-F-G-H), as shown in side view. Note that piping to and from the water box is as simple as with a standard condenser.



C. H. Wheeler

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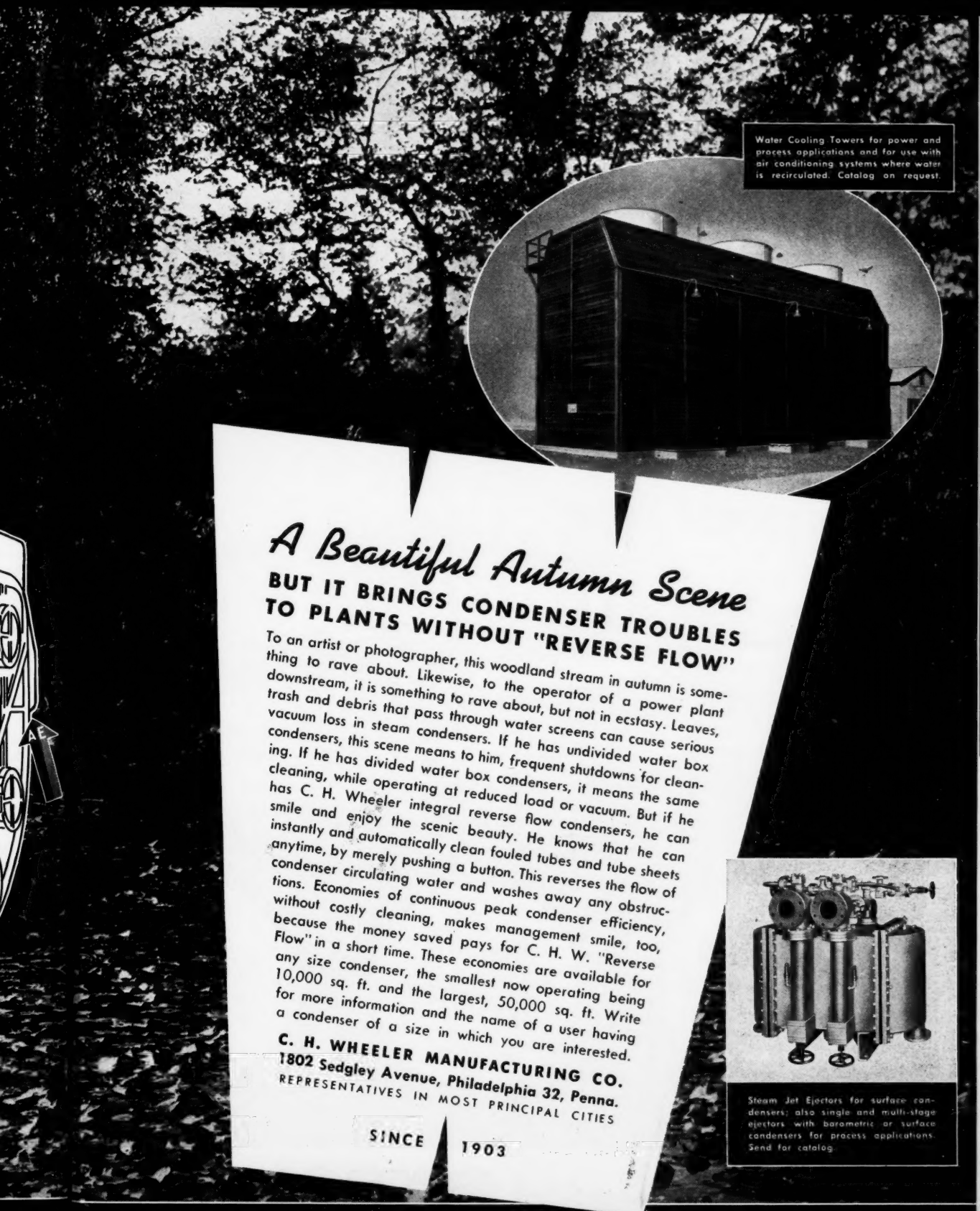


Water Cooling Towers for power and process applications and for use with air conditioning systems where water is recirculated. Catalog on request.

A Beautiful Autumn Scene

BUT IT BRINGS CONDENSER TROUBLES TO PLANTS WITHOUT "REVERSE FLOW"

To an artist or photographer, this woodland stream in autumn is something to rave about. Likewise, to the operator of a power plant downstream, it is something to rave about, but not in ecstasy. Leaves, trash and debris that pass through water screens can cause serious vacuum loss in steam condensers. If he has undivided water box condensers, this scene means to him, frequent shutdowns for cleaning. If he has divided water box condensers, it means the same cleaning, while operating at reduced load or vacuum. But if he has C. H. Wheeler integral reverse flow condensers, he can smile and enjoy the scenic beauty. He knows that he can instantly and automatically clean fouled tubes and tube sheets anytime, by merely pushing a button. This reverses the flow of condenser circulating water and washes away any obstructions. Economies of continuous peak condenser efficiency, without costly cleaning, makes management smile, too, because the money saved pays for C. H. W. "Reverse Flow" in a short time. These economies are available for any size condenser, the smallest now operating being 10,000 sq. ft. and the largest, 50,000 sq. ft. Write for more information and the name of a user having a condenser of a size in which you are interested.

C. H. WHEELER MANUFACTURING CO.
1802 Sedgley Avenue, Philadelphia 32, Penna.
REPRESENTATIVES IN MOST PRINCIPAL CITIES

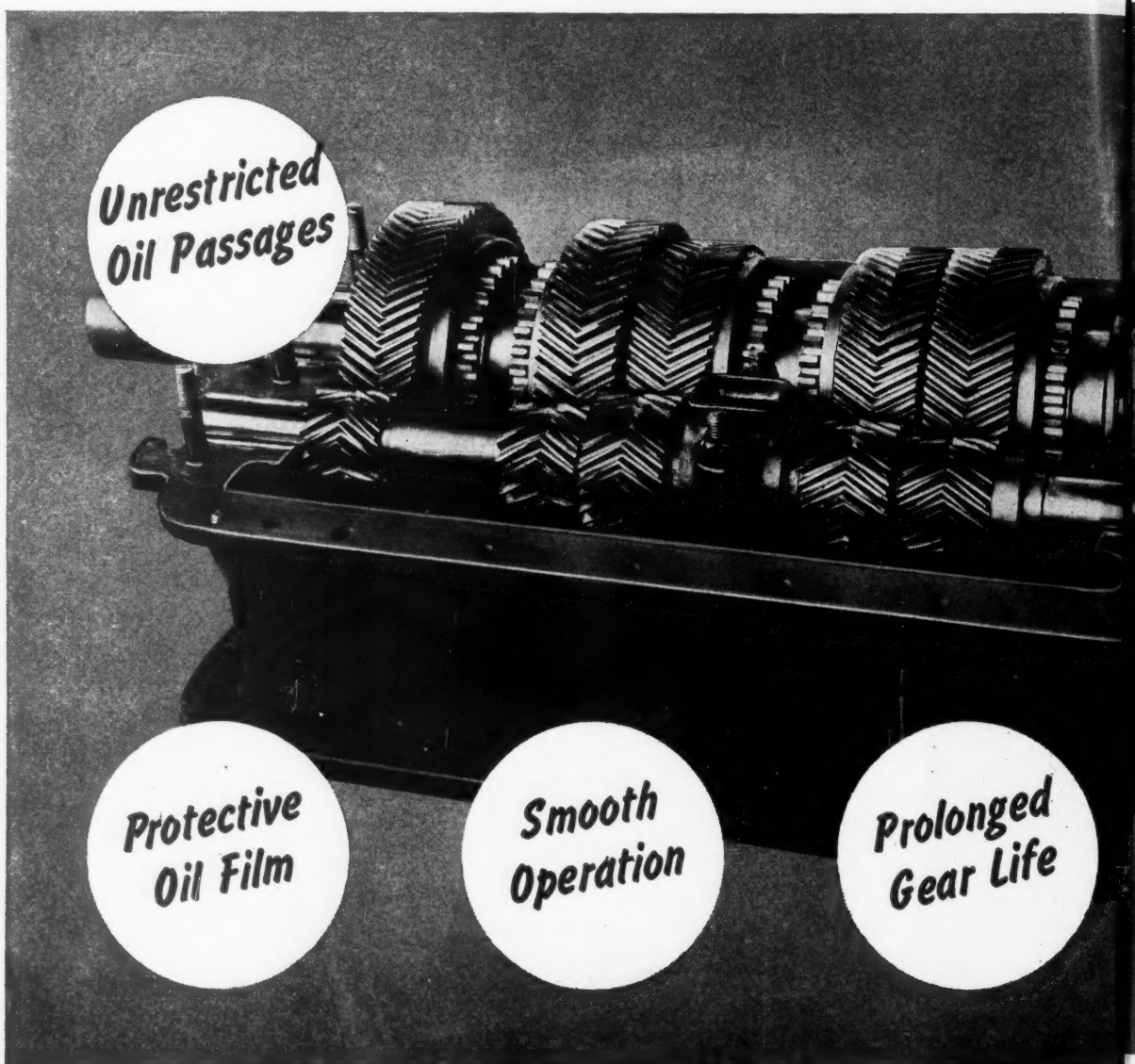
SINCE 1903

Steam Jet Ejectors for surface condensers; also single and multi-stage ejectors with barometric or surface condensers for process applications. Send for catalog.

STEAM CONDENSERS • WATER COOLING TOWERS
EJECTORS • STEAM JET VACUUM REFRIGERATION

OF PHILADELPHIA

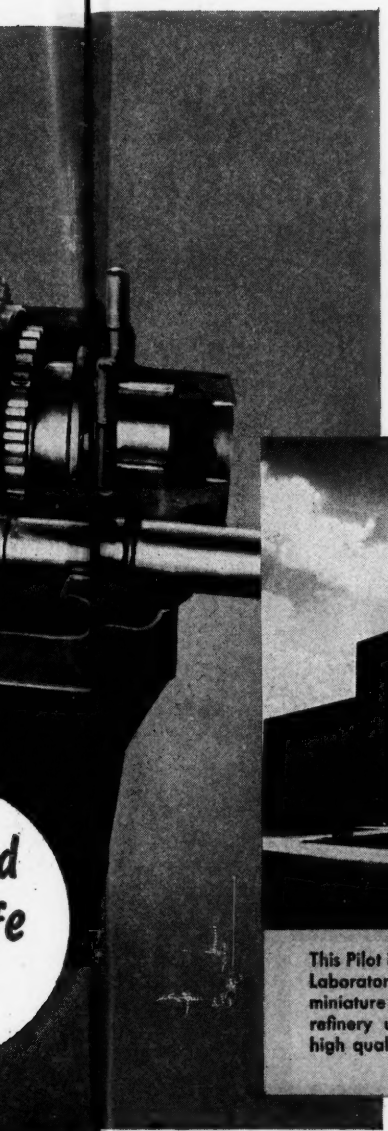
SINCLAIR RUBILENE
To Promote



SINCLAIR

YOUR NEAREST SINCLAIR AGENT WILL GLADLY ARRANGE

Withstands Punishment Gear Efficiency



Inside a Speed Reducer, the lubricating oil is being churned and temperatures run high. This promotes oil oxidation, and formation of acidic compounds, gum and sludge. The result is lower efficiency, accelerated bearing and gear wear—perhaps even complete failure.

With Sinclair RUBILENE as the lubricant, the danger of insufficient lubrication and excessive wear are no longer a worry. Product of the most modern refining processes, RUBILENE resists oxidation, thereby retarding the formation of damaging acidic compounds, gum and sludge. It is non-foaming, too. So, with a constant flow of protective oil to bearings and gears, RUBILENE stands up under the day-in-and-day-out continuous gear operation . . . without frequent need for draining or replacement. Try Sinclair RUBILENE Oils.

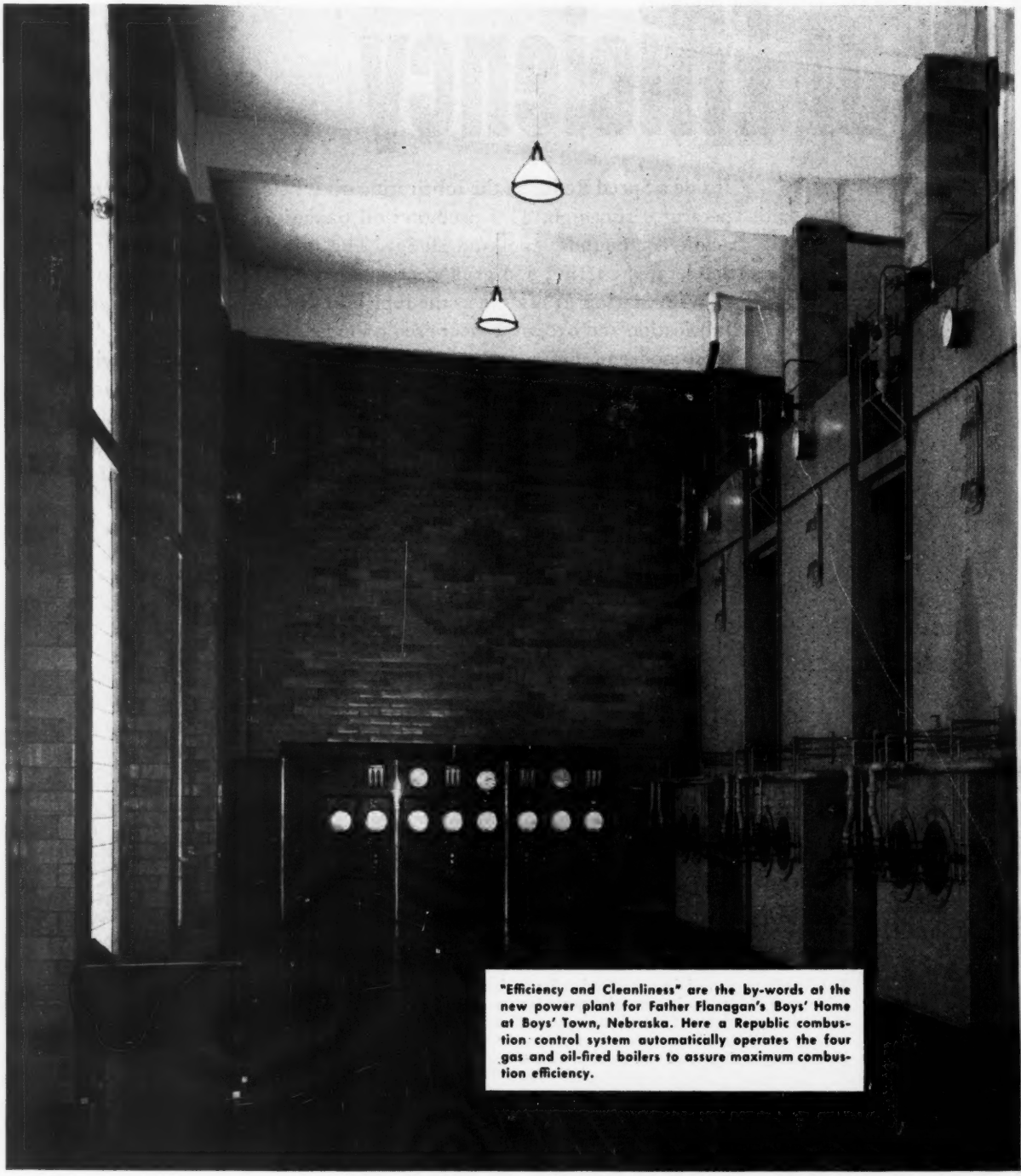
This Pilot Plant, part of the great Sinclair Research Laboratory at Harvey, Ill., provides space for six miniature operating replicas of commercial-sized refinery units. Continuous research explains the high quality of RUBILENE and other Sinclair Oils.

Making a study of crystal structure of catalysts, this Sinclair researcher at Harvey uses physical chemistry to develop refinery techniques in a never ending effort to bring industry better petroleum products at lower costs.

INDUSTRIAL OILS

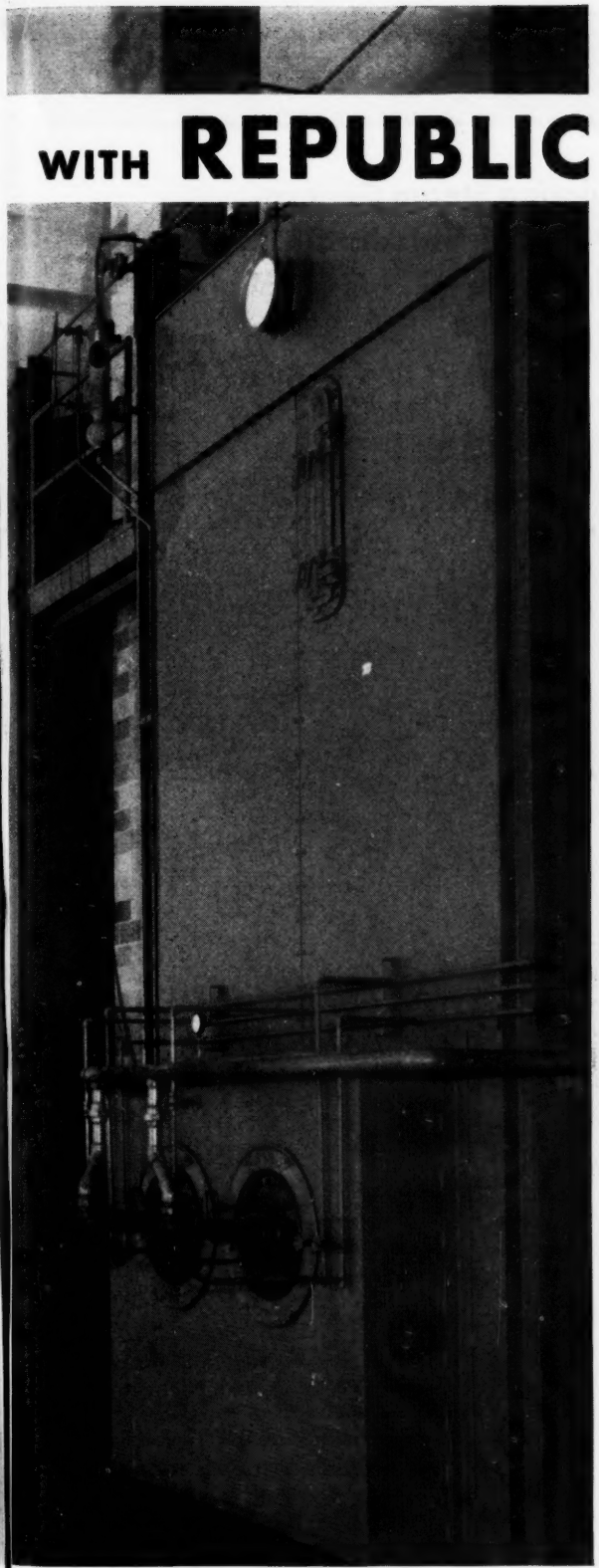
FOR LUBRICATION COUNSEL, OR YOU MAY WRITE TO SINCLAIR REFINING COMPANY, 630 FIFTH AVE., NEW YORK 20, N. Y.

More Steam FROM Less Fuel



"Efficiency and Cleanliness" are the by-words at the new power plant for Father Flanagan's Boys' Home at Boys' Town, Nebraska. Here a Republic combustion control system automatically operates the four gas and oil-fired boilers to assure maximum combustion efficiency.

REPUBLIC FLOW METERS CO.



WITH **REPUBLIC**

Automatic
COMBUSTION CONTROL

Low steam cost is not the result of efficient boiler design alone! It is determined by the degree with which your method of boiler control takes full advantage of those economies which have been "built in" your boiler and its auxiliaries.

In operating a modern boiler there are a number of repetitive adjustments which must be made frequently and practically simultaneously on several units of auxiliary equipment if highest boiler efficiency is to be maintained. The difficulty of making the required repetitive adjustments, accurately and simultaneously by hand at the individual auxiliaries, is obvious.

The REPUBLIC combustion control makes and co-ordinates these adjustments automatically, at the same time permits the operator to assume manual control from a centralized control point whenever necessary or desirable.

The REPUBLIC combustion control is a unified system controlling simultaneously, in measured quantities and in fixed (adjustable) proportions, the fuel and air input to the boiler. It increases and decreases the fuel and air supply to the boiler in the correct amount to maintain constant steam pressure and in the correct ratio to maintain maximum combustion efficiency.

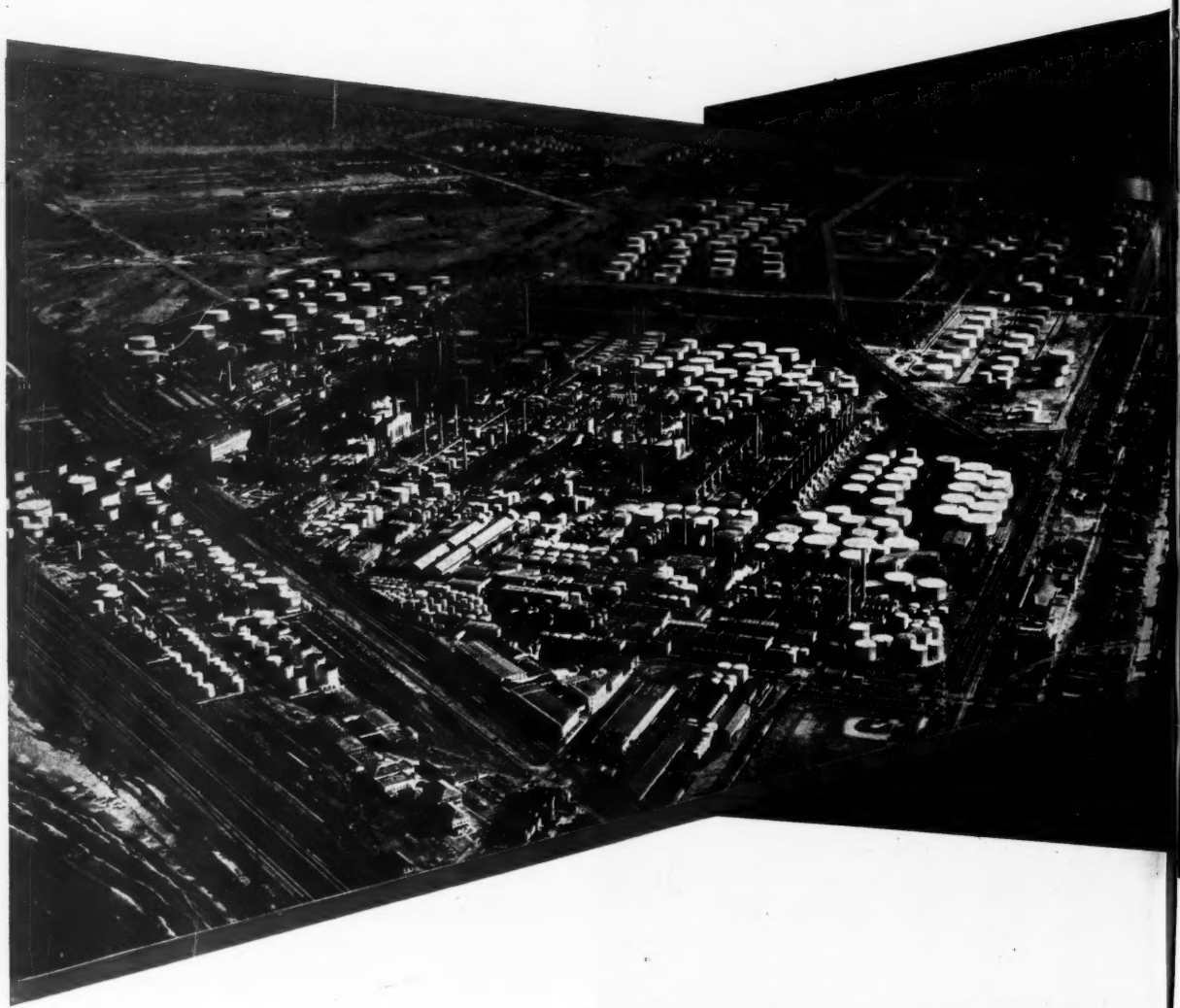
REPUBLIC combustion control systems are designed and built for all sizes of boilers — all types of fuel firing equipment — all load conditions. They fulfill all the conditions of theoretically perfect combustion control and still meet all the demands of everyday operating requirements.

Ask for your copy of Data Book S-21.

2240 DIVERSEY PARKWAY
CHICAGO 47, ILLINOIS

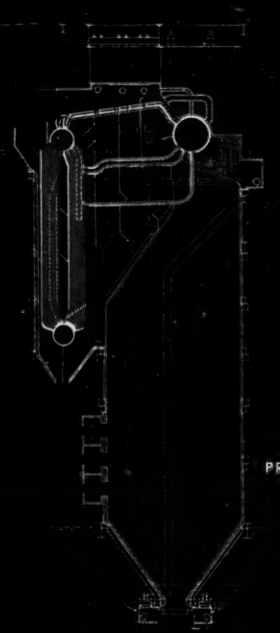
More power per lb of process steam

Foster Wheeler Dual Circulation Steam Generators at Whiting Refinery of the Standard Oil Company (Indiana) help achieve this goal



During the ninety years since the world's first oil well was drilled on the banks of Oil Creek, near Titusville, Pa., petroleum processing has evolved into an advanced science. Many new processes, resulting from continued achievements in refining practices, are being made commercially possible because petroleum engineers are alert to techniques for in-

1350 psi, 900 F operation with 100% make-up



Cross section of one of five FW Dual Circulation Steam Generators at the Whiting Refinery. Each of the two separate heat absorbing sections has its own independent circulating system.

Five FW Dual Circulation Steam Generators at Whiting deliver 300,000 lb of steam per hr each at 1350 psi, 900 F operation with 100% make-up. Because of the unique design, steam can be generated with minimum blowdown. The carryover of both solids and vaporized silica is substantially below that of standard circulation units. This assures trouble-free operation at high pressures and temperatures.

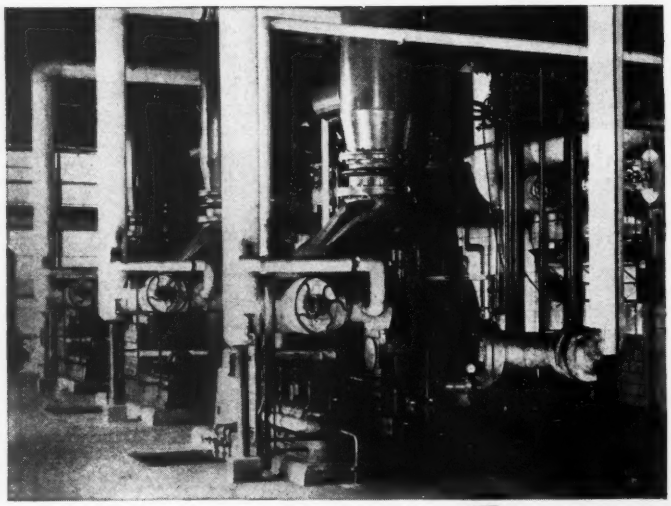
low maintenance—high turbine availability

Expensive outages for removal of silica and other deposits from turbine blades are prevented.

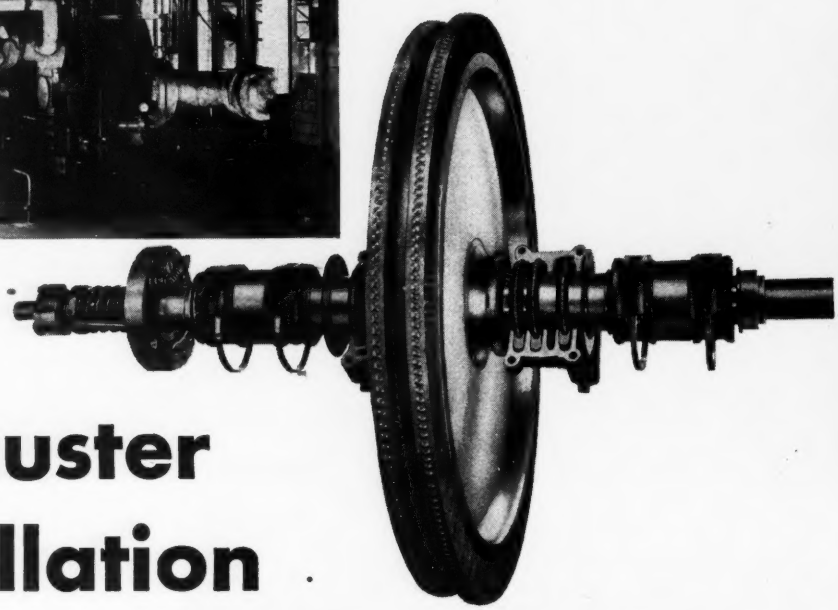
creased economy in refinery operations. The FW Dual Circulation Steam Generator is an important development in the interest of economy and helps reduce the cost of power and process steam production.

FOSTER WHEELER CORPORATION
165 Broadway • New York 6, N.Y.

The TERRY TURBINE



The rotor shown below has special stainless steel blades with heavy sections and sharp edges firmly held in a dove-tailed groove in the wheel rim.



Exhauster Installation *Features* DEPENDABILITY

These three exhausters in a Canadian steel mill, where dependability is so important, are driven by three dependable Terry Turbines, axial-flow type.

One delivers 355 hp at 4750 rpm; the other two deliver 400 hp each, at 4950 rpm. All are single stage and operate with steam at 130 psi, 100 F superheat, 15 psi back pressure.

One multi-stage bleeder unit not shown, delivers 1100 hp at 4300 rpm with steam at 120 psi, 0 F superheat, 15 psi back pressure.

If you have an application for a turbine — single stage or multi-stage — geared or direct connected — standard or special — in sizes up to 2000 hp — talk it over with Terry. It will pay.

TT-1182

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Young turbine with a bright future . . .

OFFICIALS of a midwest power company have every reason to believe that their new 40,000-KW turbine, shown above, will never have to be shut down for oil replacement, oil system cleaning, or because of oil acidity troubles. Their convictions are based on their own experience with Nonpareil Turbine Oil.

Since 1940, this company has put Nonpareil Turbine Oil into five big turbines, including the new unit. These five turbines have a total capacity of 188,500 KW. During the *one to nine years of operation* on Nonpareil, neutralization numbers have stayed below .06 mg. KOH/gm. There have been no time losses or troubles caused by high acidity. Oil systems have not required cleaning. Such benefits are assured this company, not only for 8 or 10 years, but for the *life* of its turbines. This assurance is based on Nonpareil's written guarantee that it will maintain a neutralization number below 0.15 mg. KOH/gm.

Why not end oil system maintenance and oil-acidity troubles, once and for all, by using Nonpareil Turbine Oil in your turbines? For more evidence of these savings, ask a Standard Oil Lubrication Engineer to supply you data from 20-year service records of Nonpareil Turbine Oil.

Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

NONPAREIL
Turbine Oil

"Will outlast your turbine"

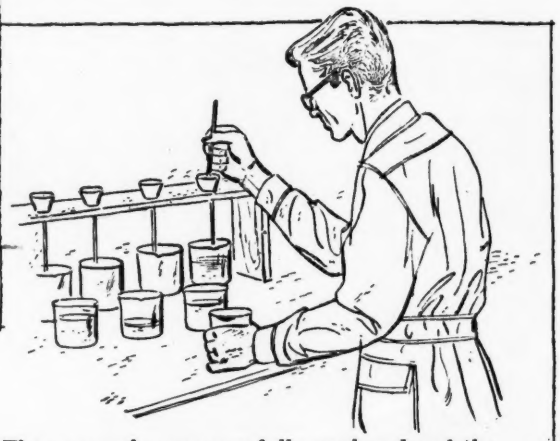
STANDARD OIL COMPANY (INDIANA) STANDARD

a Continuing Review of Conditions

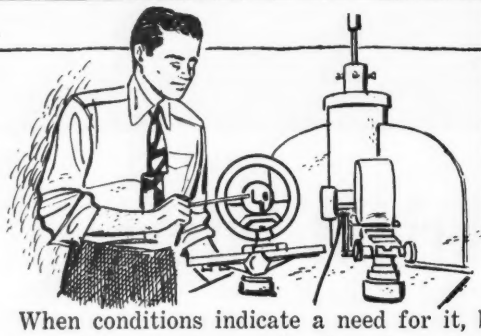
WITH HALL BOILER WATER CONDITIONING

When the Hall System of boiler water conditioning gets under way in a plant, the boiler operator can usually maintain desired conditions without difficulty. Nevertheless, he is not left entirely "on his own," for Hall continuously reviews conditions and treatment.

From time to time water samples are sent to Hall Laboratories, together with the operator's report of his test results on that water.



These samples are carefully analyzed and the analysis compared with that of the boiler operator, so that he has a check on his work.



When conditions indicate a need for it, boiler deposits are also analyzed, using chemical, X-ray, spectrographic and other methods as required.

As a result of this continuing review, the boiler operator can be confident that he is handling the water treatment properly, and that he will not be caught unaware by any change in conditions.

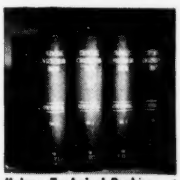
The continued attention which Hall Laboratories gives to every client is another reason why so many plants of all sizes, in all parts of the country, continue to use Hall Service, year after year. Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

HALL LABORATORIES, INC.

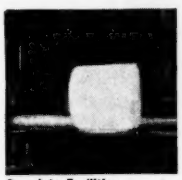
(A Subsidiary of Hagan Corporation)

CONSULTANTS ON
INDUSTRIAL WATER TREATMENT
HALL SYSTEM OF BOILER WATER CONDITIONING
INDUSTRIAL WASTE RECOVERY AND DISPOSAL

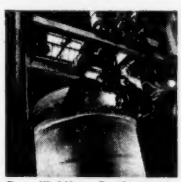
Metallurgical Research conducted continually by recognized specialists who have made major contributions in this field.



Unique Technical Backing of an extensive organization with an international reputation in both process and fabrication engineering.



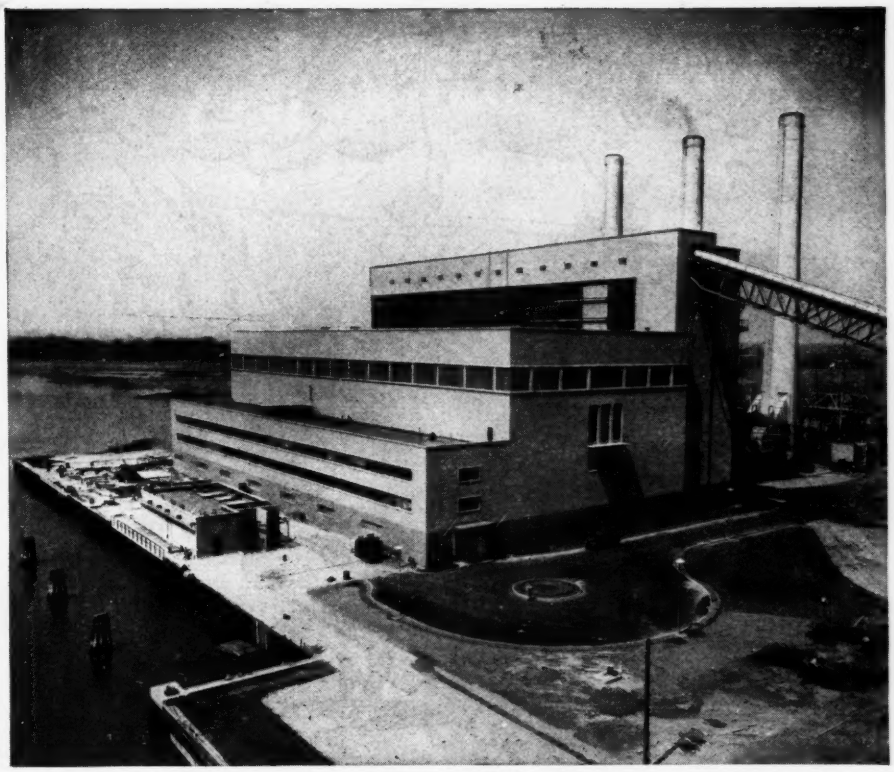
Complete Facilities for the fabrication of steel products from simple forgings to the most intricate 120 foot towers.



Top Welding Performance assured by specially designed equipment and exclusive employment of master operators.

Quality Control embracing the constant application of the most advanced inspection methods, both visual and non-destructive.

On-Time Delivery made possible by a flexible planning group authorized to re-route work to meet promised dates.



View of Public Service Electric and Gas Company's new 1500 psig., 1050 F. power station at Sewaren, N. J.

These "firsts" mean piping that lives longer

IN ADDITION to laboratory tests and actual performance figures, there are still other ways to predict the probable life of power piping. One is to look at the record of the company that fabricates the piping—to see what unusual challenges it has met and solved.

Here are three recent fabricating problems overcome by Kellogg, all connected with the high temperature piping at Public Service Electric and Gas Company's new Sewaren Generating Station in New Jersey.

Kellogg was the first to fabricate power piping to operate at 1050 F. It was not a simple job. Nothing could be allowed to go wrong in piping as important as this.

As part of this job Kellogg also fabricated the first 18-8 alloy steel (power) piping for high temperature service. It was designed to connect the throttle valves and steam chests of three turbines operating at 1500 psig. There just couldn't be any defects, any locked-up stresses, any faulty metal formations, or deviations from contour.

In addition, Kellogg created for this same plant a special bi-metallic transition piece through the use of an exclusive electric ingot casting process. It was the first of its kind and was cleverly devised to make a junction, between Croloy boiler leads and Stainless Steel (Type 347 and 316) throttle valves, that eliminated the possibility of failure from expansion stress. This piece precluded the necessity for a tricky welding job that might fail because of a 50% difference in thermal expansion between the two alloys.

These are just some recent Kellogg "firsts" to keep in mind when you place orders for power piping today. You know that each piece of piping delivered, bearing the Kellogg stamp, has not only thirty years of experience behind it, but also the creative thought that met and bested these unusual challenges. You can be sure that know-how like this means power piping that lives longer.

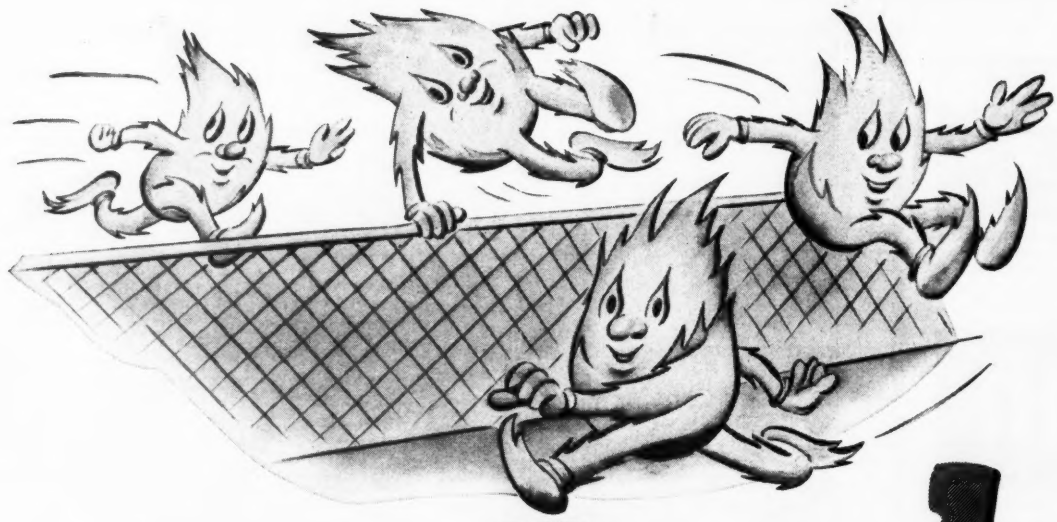
To master temperature, pressure and chemicals use

M. W. KELLOGG

process equipment

VESSELS • EXCHANGERS • CONDENSERS • HIGH PRESSURE AND HIGH TEMPERATURE POWER PIPING PROCESS PIPING • FORGED AND WELDED FITTINGS . . . IN ALL STEELS, ALLOYS OR SPECIAL COMBINATIONS

The M. W. Kellogg Company, Inc. (A Subsidiary of Pullman, Inc.) — Offices in New York, Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London and Paris.



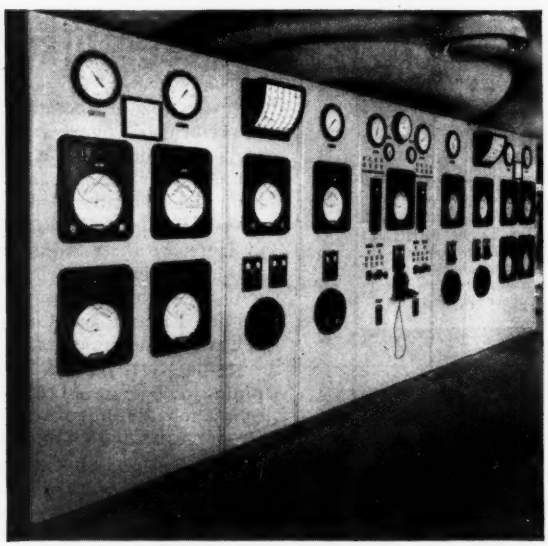
Btu's go a.w.o.l.

Every fuel has a large percentage of Btu's ready to "go over the fence". They do no work. They produce no power. The more you can keep on the job—the lower your power costs will be. And that is exactly what the Bailey co-ordinated boiler control system can do for you.

It reduces fuel consumption per pound of steam generated. Combustion, feed water, steam temperature, heater levels, pump speeds and all other factors are co-ordinated—automatically controlled. With Bailey Controls safety of operation is increased—continuity of service is improved. You convert the maximum number of Btu's into power. You get full efficiency from your boiler.

Many Bailey co-ordinated boiler control systems have paid for themselves in fuel saved in less than one year. All do not return their original cost as quickly as this. But the quick way to find out how Bailey boiler control will work for you is to talk to one of our Engineers. Bailey co-ordinated boiler control is not a package unit. Each must be engineered to the specific job.

If you are looking for low cost power, it will pay you to call our nearest office.



These Bailey Controls help operators to prevent Btu's from going a.w.o.l. in an Oil Refinery.

BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND 10, OHIO

BAILEY METER COMPANY LIMITED, MONTREAL, CANADA

BAILEY METERS

Controls for Steam Plants

COMBUSTION • FEED WATER • TEMPERATURE

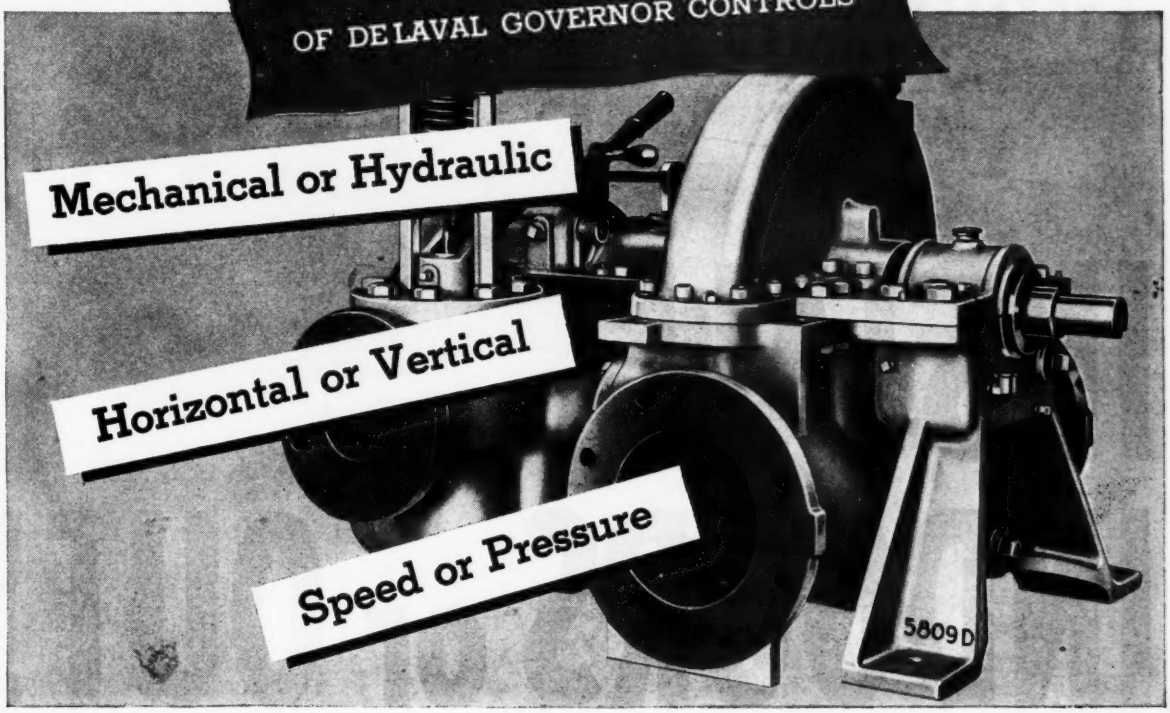
PRESSURE • LIQUID LEVEL • FEED PUMPS

A-105

Branches in: Boston, New York, Schenectady, Philadelphia, Buffalo, Pittsburgh, Charlotte, Cleveland, Detroit, Cincinnati, Atlanta, Chicago, Milwaukee, St. Louis, New Orleans, St. Paul, Kansas City, Houston, Denver, Los Angeles, Seattle, San Francisco

Take Your Choice

OF DE LAVAL GOVERNOR CONTROLS



Whatever your control requirements, De Laval Class CA Turbines can be equipped with a governor that will meet the demand. The following types are available:

1. *Mechanical shaft governor* with smooth-acting, long-wearing "rocking chair" action.
2. *Vertical mechanical governor* geared to shaft for speeds above 4500 rpm.
3. *Hydraulic governor.* Direct acting orifice-type for high speeds and/or wide range of speed adjustment.
4. *Hydraulic oil relay* for close regulation or for supplying extra power for valve movement.
5. *Flyweight oil relay* for close regulation such as encountered in synchronous generator drives.
6. *Pressure controls* for constant pressure or differential pressure regulation of pumps, blowers, etc.
7. *Speed changers,* manual or remote control by electric motor drive with vertical mechanical governor.
8. *Oil pressure trip* to shut off steam if oil pressure falls in turbines equipped with forced feed lubrication.

Combinations of the above types can be supplied as required to meet specialized conditions.

Before you buy a turbine, be sure and get complete information on these additional De Laval features:

- ✔ True center line support and flexible mounting for perfect alignment.
- ✔ Balanced double-seated bonnet-type governor valves for close control of steam flow.
- ✔ *Positive* over-speed protection entirely separate from normal speed governor for unfailing emergency shut-off.
- ✔ Super-smooth, chrome plated shaft journals make carbon rings last longer.
- ✔ Casing and bearings split horizontally at center line for easy removal and inspection of the rotor, carbon rings and bearings.

SEND FOR CATALOG 4202-26-G

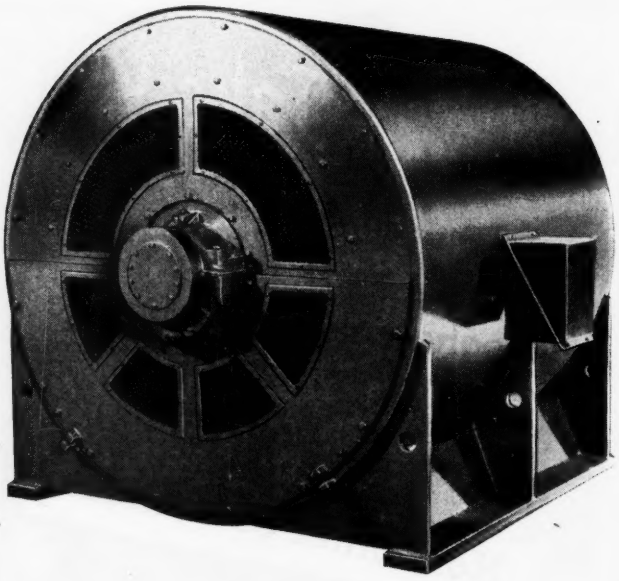
DE LAVAL

DE LAVAL STEAM TURBINE COMPANY, TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

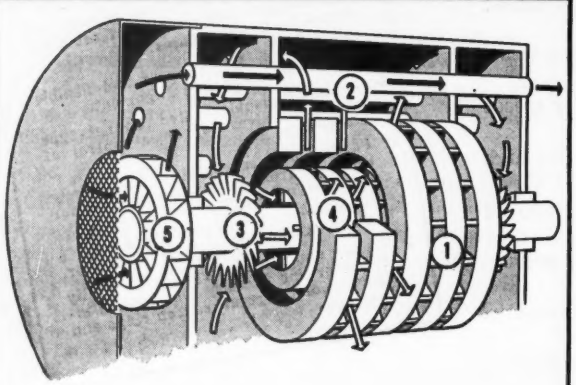
T-26

TUBE-TYPE
TOTALLY-ENCLOSED FAN-COOLED MOTORS!



INSTALL INDOORS or OUT!

How Tube Cooling Works



Stator core (1) is surrounded by tubes (2). Internal fans (3) circulate air through ducts (4) in rotor and stator and around tubes, transferring heat to tubes.

External fan (5) drives outside air through tubes, removing heat and keeping tubes clean. All electrical parts are enclosed. Dirt cannot enter.

- **Dirt-proof and corrosion-resistant**
- **Heat exchanger is practically *self-cleaning***
- **Simple self-contained cooling system—sizes from 75 to several thousand horsepower**

WHEREVER DUST, DIRT, fly ash, rain and snow, smoke, or corroding fumes keep motor maintenance costs high, this Allis-Chalmers tube-type motor will cut maintenance sharply.

All electrical parts—including stator core—are enclosed. Simple heat transfer system keeps temperatures well within rated limits. Cleaning is rarely needed because air passages are unrestricted. Air flow through the straight tubes removes foreign matter.

Important savings have been proved in three years of field operation. Sizes from 75 hp and up. Also explosion-proof designs. For complete information, outline your requirements to your A-C Sales Office, or write for Bulletins 05B7150 and 51R7149.

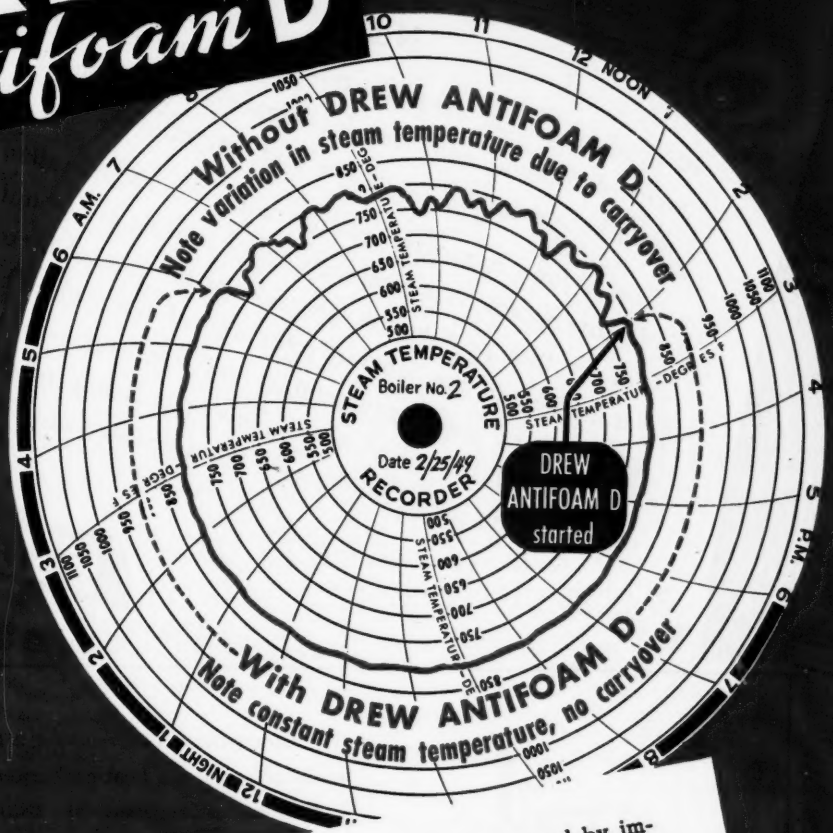
A-2610

ALLIS-CHALMERS, 953A SO. 70 ST.
MILWAUKEE, WIS.

ALLIS-CHALMERS

STOP BOILER FOAMING and CARRYOVER WITH

DREW *Antifoam D*



Carryover of moisture and solids with steam may be caused by improper chemical conditions in boiler water. In addition to heat losses, carryover causes steam line, superheater and turbine deposits.

DREW ANTIFOAM D controls foaming and carryover at all pressures, including the high pressures encountered in modern boiler design. When combined with Drew Organics, sludge adherence and feedline deposits are also eliminated. It is economical and simple to use.

Your local Drew engineer is available to discuss all aspects of water treatment and related problems.

POWER DREW CHEMICALS

E. F. DREW & CO. INC.

15 E. 26th ST., NEW YORK 10, N. Y.

360 N. Michigan Ave. Chicago, Illinois

268 Market Street San Francisco, Cal.

BOILER WATER TREATMENT
COOLING WATER CONDITIONING

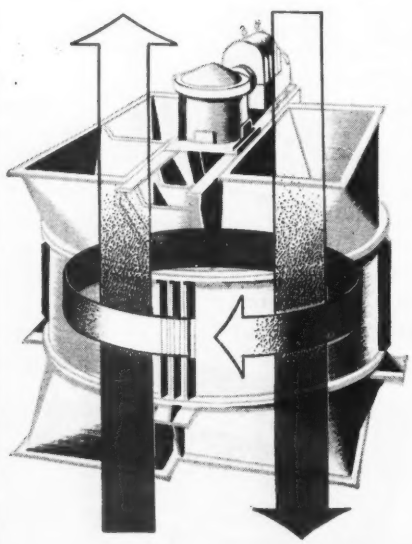
Fact File on Preheat

No. 5

In the Ljungstrom air preheater the compact arrangement of rotating heat transfer elements assures maximum heat recovery for its size and weight.

The higher recovery possible with the regenerative feature more than compensates for the small amounts of air that pass to the gas side of the heater by entrainment in the moving rotor and at the seals. This passage of air is predictable and consistent during the life of the plant with allowance being readily made in the initial selection of the preheater and fans.

LJUNGSTROM



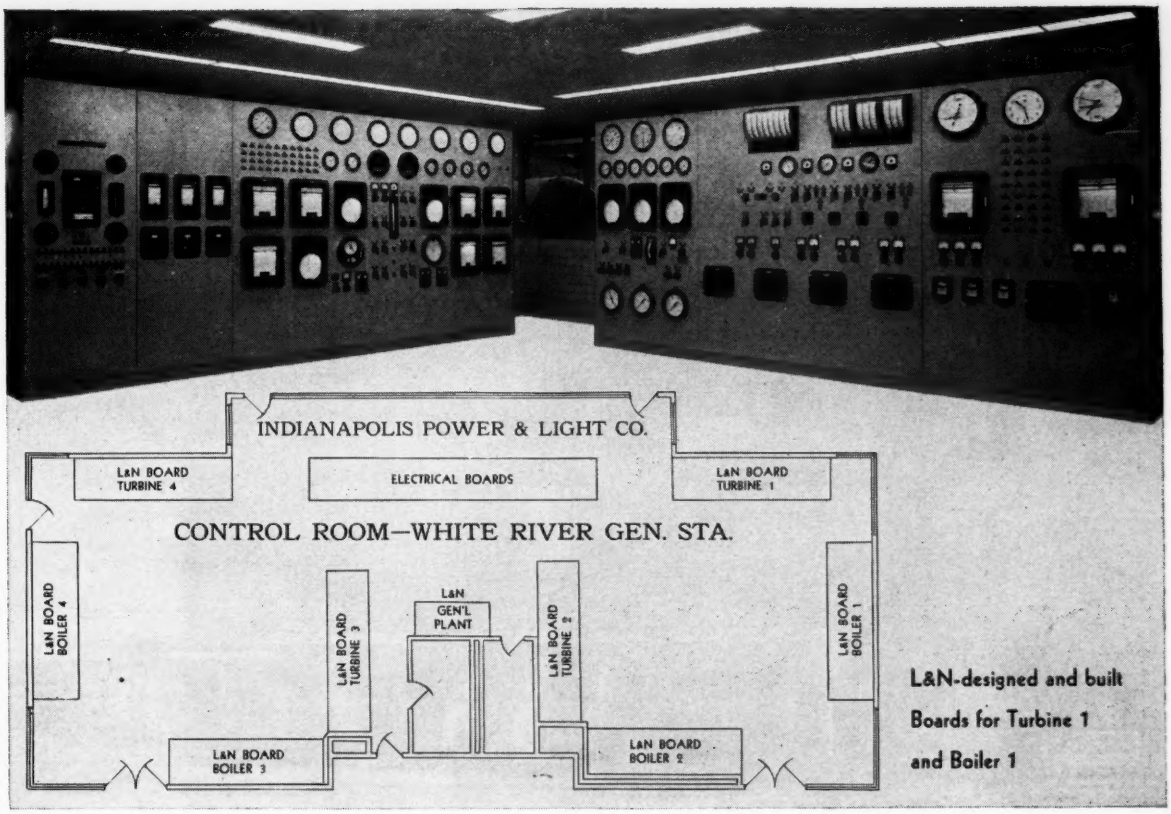
The Ljungstrom Air Preheater is a compact gas-to-air or gas-to-gas heat exchanger, operating on a continuous regenerative counterflow basis. Hundreds of leading power plants and other special applications confirm its high level of heat recovery and long-term low maintenance service.

THE

AIR PREHEATER CORPORATION

60 EAST 42ND STREET • NEW YORK 17, N. Y.

Plant: Wellsville, N. Y. 2410



L&N-designed and built Boards for Turbine 1 and Boiler 1

"PACKAGED" CUBICLES BY L & N SIMPLIFY CENTRAL CONTROL PROBLEMS

Indianapolis Power & Light Company is one of the public utilities which believes firmly in centralizing the control of boiler, turbine and generator at one spot in the plant.

In referring to the new White River station, for example, the Company says:* "The most unusual feature is the centrally-located Control Room which will eventually contain panels, instruments and controls for completely operating four units. Panels are arranged to give each operator a clear view of his boiler or turbine . . . remote indication of all operating flows, pressures, temperatures and liquid levels (are provided) . . . with suitable alarms."

"Panels supplied by Leeds & Northrup Co., contain controls for one boiler with convenient grouping . . . turbine controls on their own panels. An L&N general plant panel provides for air compressors, well-water and ash-sluicing pumps, water softener and station barometer plus alarms for necessary items. The control room is ventilated by a forced-air system . . . "

The engineering service rendered to I.P.&L. and to Gibbs & Hill, design and construction supervisors on the whole Station, extended far beyond the supplying of L&N instruments and controllers. After the owner and consultants had okayed our general suggestions, we completely engineered and built the boards. The assembled and tested equipment reached White River ready for connections to boiler, turbine and generator auxiliaries. The user saved much engineering and installation time, with associated reduction in overall cost, and has, in effect, a huge "instrument" for specific needs, to provide efficient operation with maximum ease and reliability.

Seventh Project in 17 Years

Six other applications of L&N equipment have been made for I.P.&L.; the first, involving both Combustion Control and Instruments, went into service in 1932, and White River is the Company's fourth station to use our products and services.

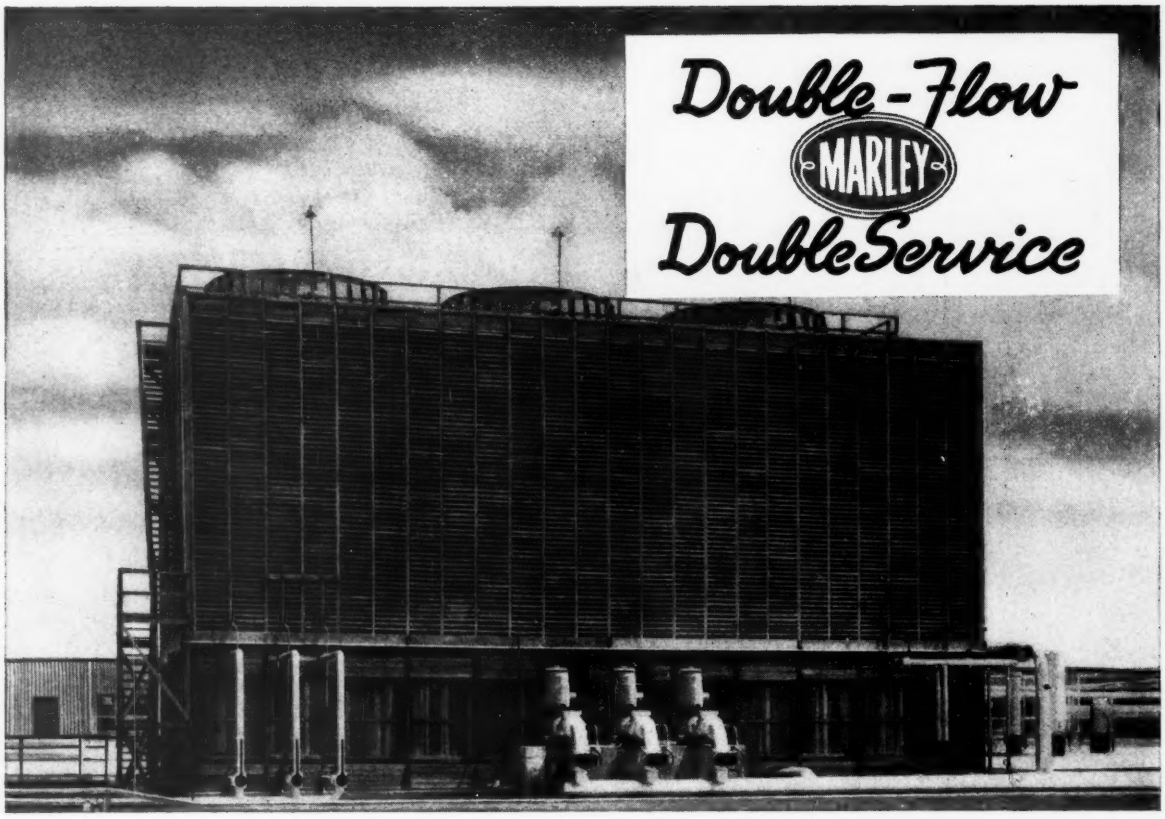
L&N control-engineering service is available for any control-panel problem, whether it involves an entire station, or just one instrument. Address Leeds & Northrup Co., 4973 Stenton Ave., Philadelphia 44, Pa.

*"*New 160,000-Kw White River Generating Station of Indianapolis Power & Light Co." by A. A. Benson;* Combustion, *May 1949.*

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Jrl Ad N-460(3)



FOR THOSE "*EXTRA TOUGH*" WATER COOLING JOBS

MARLEY DOUBLE-FLOW COOLING TOWERS are built to "Take It"! For unusually heavy water cooling requirements . . . open, closed or combination cooling . . . in any kind of weather . . . and in abnormally corrosive atmospheres, the MARLEY DOUBLE-FLOW is designed to give consistent, around the clock service with a minimum of maintenance time and expense.

This is true because MARLEY DOUBLE-FLOW has these outstanding, exclusive features:

OPEN DISTRIBUTION SYSTEM . . . On top of the tower, in plain view, easy to inspect, regulate and clean.

NO DEAD AIR POCKETS . . . Every drop of water meets a steady flow of air as it splashes down thru Marley's patented nail-less filling.

BETTER MECHANICAL EQUIPMENT . . . Equipped with Marley engineered and Marley made fans, fan cylinders, drive shafts and Geareducers . . . your assurance of top quality.

SOUND STRUCTURES . . . Double-Flows have withstood hurricanes, earthquakes and corrosive atmospheres because all lumber, hardware, supports, bracing and columns are designed to make an engineered structure.

COMPLETELY SAFE OPERATION... Stairways, handrails, walkways, and fan cylinders insure safe operation and maintenance in any kind of weather.

MINIMUM DRAFT LOSS . . . Drift eliminators set in slanting position allow greater area for air passage, minimizing draft loss and reducing horsepower requirements.

GREATER COOLING CAPACITY . . . Packed with decks of nail-less filling, Double-Flows have more wetted surface therefore greater cooling capacity.

If you're looking for GREATER SERVICE, LOWER COST and IMPROVED WATER COOLING EFFICIENCY in your plant, be sure to ask a MARLEY "Double-trained" APPLICATION ENGINEER to analyze your situation and recommend the COOLING TOWER you need to meet your requirements. There's no cost or obligation.

Photo by Elwood Payne

MARLEY COOLING TOWERS

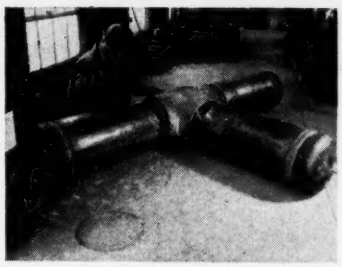
THE MARLEY COMPANY, INC. • KANSAS CITY 15, KANSAS

WATER COOLING TOWERS · DRICOOLERS · SPRAY NOZZLES

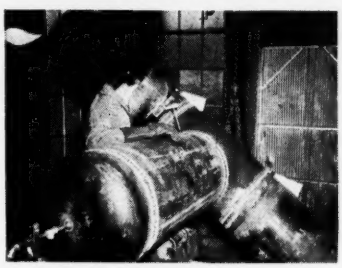
TUBE-TURN

tt

WELDING FITTINGS
AND FLANGES



18-inch standard weight Tube-Turn welding tee and pipe laid out preparatory to assembly for hydrostatic pressure test.



Welder completing last bead in assembly. Fitting and pipe now form homogeneous, leakproof unit.

Assembly is hung in pit, massively lined with concrete. During test top grating is closed and held down by a barricade of sandbags.

Final result after hydrostatic pressure test. The straight pipe burst first, and the tee is undamaged.

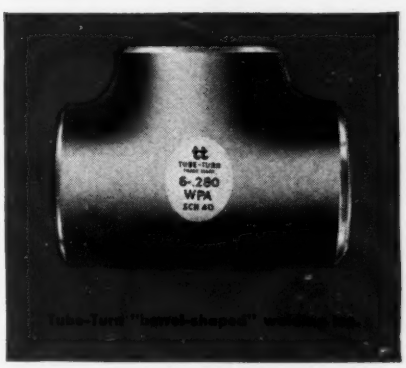
Strength through Design in Tube-Turn welding fittings

The pipe burst first!

Take an 18-inch standard weight welding tee. Take three corresponding lengths of pipe. Weld tee and pipe together. Cap the ends. Lower the assembly into a pit. Then apply hydrostatic pressure—much more than the assembly is supposed to take!

Something has to give! According to the accepted beliefs it should be the tee. But not in the case of the test pictured here. The Tube-Turn "barrel-shaped" tee was used—and the pipe burst, well before the tee was affected! Throughout numerous tests, this new type of tee has withstood at least 25 per cent more pressure than required by the formula given in ASA B16.9.

The superior strength of the tee was achieved without running up extra weight and cost, by carefully planned improvements in shape (based on the sphere, nature's strongest form for internal pressure), and by a carefully engineered distribution of metal.



Tube-Turn "barrel-shaped" welding tee.

This is a typical example of *strength through design* in Tube-Turn welding fittings, and another good reason why leading piping engineers specify Tube-Turn equipped, welded piping.

TUBE TURNS, INC.

234 East Broadway, Dept. L Louisville 1, Kentucky

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HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

ELECTRICAL

101 **Time Current Data**—An "all-in-one" package of time-current information and engineering notes, this data is visibly filed in separate indexed folders for each fuse line. Curves are printed with colored inks on transparent paper. Includes total clearing time, minimum melting time and short time rating curves drawn on fine scale NEMA grids; designation of fusible element construction used in each fuse or fuse refill unit and effect of construction upon accuracy and "non-damageability" of element; rebuttal of arguments that short-time curves or "set back" allowances are essential in coordination of all fuses; variations in melting time characteristics caused by "pre-loading" and ambient temperature changes; also added speeds—standard, slow, and time-lag characteristics with average speed ratios. An excellent—and costly compilation of technical information, this book is free to qualified power engineers. S & C Electric Co.

102 **Switchboards**—Catalog PL 100 contains 11 pp covering power control equipment and features large pictures of panel boards, gage boards, switchboards and control consoles. It's loose leaf bound so latest equipment and application sheets may be added as published. Tells how purchaser's requirements can be met by company's engineering services. Taller & Cooper, Inc.

103 **Unit Cooled Motors** — Constant or adjustable speed d-c motors of 15 to 200 hp for use in dusty, dirty, or oil laden atmospheres are featured in 4-pp illustrated Bulletin GEA-4469A. Discusses design features of construction which afford ventilation independent of motor speed, and promote savings in time and maintenance. Pictures both a single and double blower model. Gives operating characteristics. Apparatus Dept., General Electric Co.

104 **Photoelectric Cells** — Technical Bulletin PC-649, 4 pp, on manufacturer's line of selenium self-generating photoelectric cells, contains diagrams and curves illustrating the construction, performance characteristics and applications of the photocells. Curves showing the cell's current sensitivity, voltage output, internal resistance, spectral sensitivity are also featured. A price list indicating company's standard sizes and discount schedule is also included. International Rectifier Corp.

105 **Enclosed Motor Design**—Form 1524, 8 pp, features the new developments in electric motor design incorporated in manufacturer's horizontal enclosed motor, available in ratings from ¼ to 250 hp. These design features are illustrated by natural color photographs and progressive drawings. Bulletin discusses the economy, safety and other advantages of the motor, describing the windings, housing, lubrication, castings, ventilation, rotor and laminations. Also explains temperature rise in motors and its effect on windings. U. S. Electrical Motors, Inc.

106 **Replacement Unit**—A unit specially adapted for replacing obsolete oil circuit breakers of insufficient interrupting capacity in older distribution substations is presented in 4-pp Bulletin 18B7094 as a means of modernizing existing stations to handle increased generating capacity and meet faster relaying requirements. Contains complete dimensions and range of ratings of the unit, together with a description of a typical installation. Also included are photos of the unit and drawings to show principles of contact separation. Allis-Chalmers Mfg. Co.

FIRING EQUIPMENT

107 **Spreader Stoker**—A stoker designed to feed wet or dry coal without clogging and deliver high combustion efficiency at low cost per pound of steam is featured in Form 520, 14 pp. Illustrates and describes construction of stoker, its rotor, grate drive and grate design, also cinder reinjection and overfire air systems. Large sectional drawings in full color show a stoker with continuous ash discharge and one with dumping or stationary grate. Photos and drawings of typical installations are included. American Engineering Co.

108 **Combustion Control**—Bulletin C-22, 16 pp, covers automatic combustion control equipment for economical and efficient boiler operation and applicable to coal, oil or gas firing. Describes and illustrates a steam pressure regulator, air flow regulator, draft regulators and sequence draft regulator. Emphasizes "packaged" feature of these controls and availability of control system best suited to individual plant requirements. Ace Instrument Co., Inc.

109 **Oil Burning Systems**—This is 4-pp bulletin on manufacturer's industrial oil burning systems featuring manual or automatic control of burners. Describes briefly and illustrates, by photo, eight types of burners, giving sizes. Also describes and illustrates forges and furnaces, fuel oil heaters, valves and strainers. The Anthony Co.

INSTRUMENTS AND CONTROLS

110 **Helicoid Pressure Gages**—Sixteen-pp Catalog DH-818 explains in detail how manufacturer's helicoid gage operates and at the same time familiarizes users with the various parts, including the helicoid movement. Parts are easily identified by large cutaway illustrations. Also included is complete information on the Bourdon tubes used, the external point adjuster, standard gage accessories, case designs, dimensions and shipping weights. Prices given for accessories. Helicoid Gage Div., American Chain & Cable Co., Inc.

111 **Liquid Level Gages**—Unit 120, 2 pp, describes and illustrates manufacturer's dial-type gages for distance reading of boiler and other water levels. Explains how the gage works, its construction, and mounting, also its use with alarms. Illustrations include schematic diagram of the gage and photo of the dial. Jerguson Gage & Valve Co.

112 **Alarm Silencer** — One-pp Bulletin 7400 completely illustrates and describes briefly an automatic alarm silencer, telling some of its applications. It also provides an explanation of its operation, and includes an easily-followed wiring diagram. Automatic Control Co.

113 **Flow Meters** — The high accuracy, safety, flexibility, low maintenance, and other features emphasized for manufacturer's "Magna-Clutch" mechanical flow meters are explained in 8-pp Bulletin 49-915. Illustrated with photos and operational drawings, it also contains dimensional and meter piping sketches as well as engineering specifications. The Hays Corp.

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RUBBER AND RUBBER PRODUCTS

114 **Rugged Rubber** — Catalog Section 9010, 4 pp, outlines the recommended uses for various grades of Armorite, described as the toughest abrasive-resistant rubber known. The material is used to line chutes, pipes, sandblast cabinets and, according to catalog, has great resistance to cutting action. Describes construction of several types of this material, giving specifications and data. The B. F. Goodrich Co.

115 **Rubber Resurfacing** — "How to Resurface and Repair Rubber Lined and Hard Rubber Equipment," is the title of 4-pp Bulletin C-3, which tells how to analyze a repair job, suggests materials to be used and explains how to use them. Instructions cover preparation of the surface, mixing the cement and applying it. Common corrosives to which manufacturer's products are resistant are listed, and applications for five of these cements are discussed. Carboline Co.

116 **Products for Petroleum** — Booklet 6903, 16-pp describes rubber and asbestos products for the petroleum industry, covering equipment used in oil production, refining, transporting and maintenance. Contains descriptions of new products and information on rotary and other hose, belts, brake blocks, packings and gaskets. Photos show equipment, many installations. Manhattan Rubber Div., Raybestos-Manhattan, Inc.

117 **Variable Speed Control** — Eight-pp Bulletin VN-4912, describing improved design of manufacturer's variable speed control for light horsepower requirements, includes description, photos, rating and dimension tables and prices. Text and illustrations cover operation of unit, its simplicity of installation, and applications. Includes several photos showing the unit applied to presses, other machinery. Reeves Pulley Co.

118 **Transmission Belting** — Catalog M-9922, 28 pp, gives detailed design, engineering and performance data on manufacturer's line of transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors are included in the manual, together with hints on proper selection of a belt and procedure for analyzing belt drives. Illustrations include many photos of belt installations and drawings showing types of transmission drives. United States Rubber Co.

VALVES AND ACCESSORIES

119 **Valves and Specialties** — The gate and needle valves, screw machine products, hose nipples, tubes, flanges, hot rolled bars and welding electrodes described in Bulletin W-350-B5B, 6-pp, are made of Worthite, a stainless alloy produced for company for use in valves handling corrosive solutions, many of which are listed. Gives sizes, specifications for all equipment listed, includes photos. Worthington Pump and Machinery Corp.

120 **Safety Heads**—Bulletin A-47 is an 8-pp booklet covering safety heads, safety head flanges, safety head rupture discs and relief valves, automatic chemical feeders and pressure vacuum vent valves. Twenty-seven photos and drawings illustrate products and fittings. Charts give capacities, ratings and specifications. Black, Sivalls and Bryson, Inc.

FUEL OIL, LUBRICANTS

121 **The Answers on Turbine Oil**—This 12-pp booklet answers several questions power engineers ask about turbine oils, including: What causes deposits or sludge? What causes acidity increase? What causes corrosion in turbines? Explanations are brief but thorough. Booklet is illustrated with photos of turbine installations in which manufacturer's products have been used successfully. Standard Oil Co. (Indiana).

122 **Oil Conditioner**—Eight good reasons for using manufacturer's oil conditioners are presented in this 4-pp bulletin. It also explains how this product works to condition fuel oil and effect a chemical removal of sludge, touching upon some of the problems caused by "that imp, Sludgey". Alken-Murray Corp.

TOOLS

123 **Cutting and Threading Tools**—Catalog 49 is a 36-pp manual crammed with useful information on a complete line of hand and electric power tools for cutting and threading pipe, bolts and conduit. Photos and other illustrative material show the tools as they actually look and cross-sectional drawings indicate, step-by-step, the way they function. Specifications are easy to read and every tool is coded to simplify ordering. In addition to describing each tool, text covers its applications, important design features and maintenance. Beaver Pipe Tools, Inc.

124 **Tube Expanders**—Bulletin 420, 6 pp, gives data on tube expanders for condensers, heat exchangers and general small tube rolling. It explains that these expanders incorporate a new, improved, adjustable ball bearing thrust collar and are designed for efficient, easy rolling and maximum roll length adjustment for various tube sheet thicknesses. Four models are shown. Also illustrated is a complete line of tools and wrenches for heat exchanger tube assembly as well as various models of tube cleaners. Thomas C. Wilson, Inc.

PUMPS

125 **Turbine Pumps** — Bulletin 1014, 10 pp, explains and illustrates water lubricated deep well turbine pumps, telling their applications and emphasizing the economy of their interchangeablity of parts. Large cutaway illustration shows component parts and operation of both the closed impeller and the semi-open impeller type pump. Sketches show how these vertical pumps are adaptable to various power drives. Also describes briefly manufacturer's oil lubricated pumps. Johnston Pump Co.

126 **Centrifugal Pumps** — Construction features of a single stage, double suction pump developed for high efficiency and low maintenance are described in 24-pp Bulletin 08B6146A. Carrier tables of sizes, approximate dimensions and head capacities, tells how to figure pumping head, and tabulates friction loss for water per 100 ft of pipe. Installations utilizing these pumps, according to bulletin, include filtration and sewage plants, pumping stations, steam power and chemical plants. Allis-Chalmers Mfg. Co.

127 **Oil Pumps**—Catalog L-31P-A, 12 pp, describes pumps designed to deliver a continuous flow of fluids, including viscous oils, pumps which require little space and run at motor or turbine speeds. Illustrated throughout with photos of installations, this bulletin tells how pumps are made, how they operate at high speed and are easily accessible. Includes dimensions, capacities, speeds. De Laval Steam Turbine Co.

METALS

128 **Alloy Analysis**—Bulletin TR-506 is a 26-pp technical study covering properties and characteristics of 27 per cent chromium-iron. The text, accompanied by photos, charts and tables, includes a description of the alloy, its properties at high temperatures, impact properties, notch sensitivity, structural characteristics, embrittlement phenomena, working and fabricating and annealing. Also includes a 4-pp selected bibliography. The Babcock & Wilcox Tube Co.

129 **Sheet and Plate Alloy** — Eight-pp Bulletin 502 features the advantages and applications of a corrosion resistant sheet and plate alloy, Durimet 20, recommended for laboratory fume ducts, hoods, table tops, troughs, and battery room ducts. Tells chemical composition, mechanical and physical properties of the alloy, discusses the corrosion protection afforded by it and lists common corrosives to which it is resistant. Pictures several installations, lists many others. Also covers fabrication of ducts and gives available gages, sizes, weights and finishes. The Duriron Co., Inc.

MISCELLANEOUS

130 **Belt Conveyors** — "Move More for Less" is the title of 32-pp Bulletin 1400 presenting information on stationary, portable and special purpose belt conveyors, both troughed and flat belt. Included

(Continued on page 118)

OCTOBER, 1949
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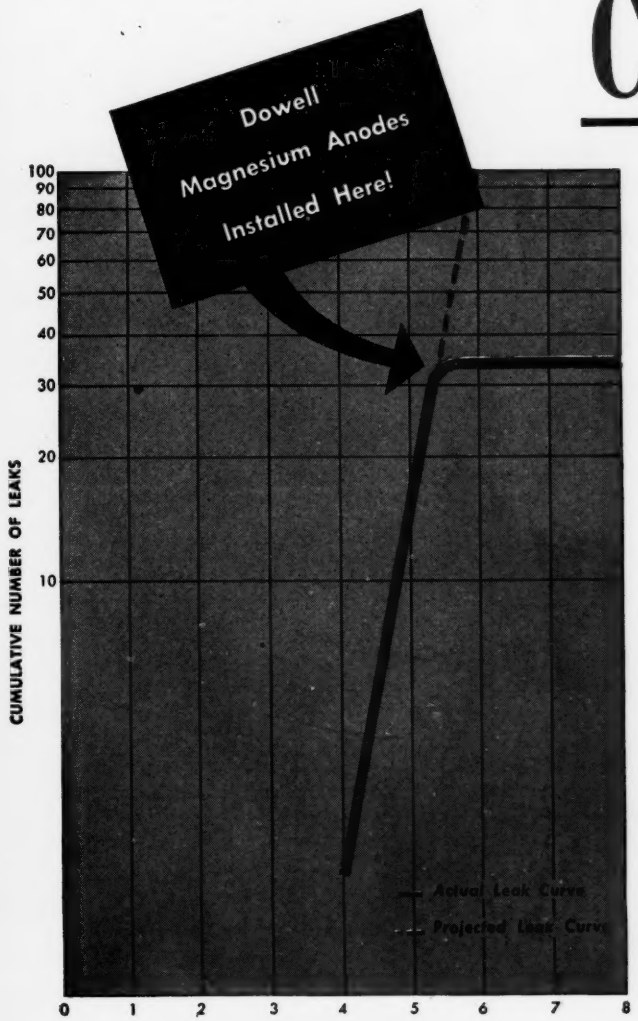
Here's How . . .

PIPELINE MAINTENANCE COSTS CAN BE CUT!



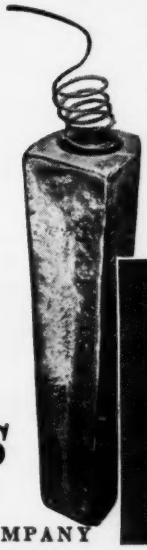
One way to lower pipeline maintenance costs is to reduce the number of leaks. The graph at left shows how a Gulf Coast city cut leaks in a 27 block, 2" galvanized piping system. The system was installed in 1940 and 1941. By April, 1946, leaks were appearing at an accelerated rate. *Then, magnesium anodes were installed!* Result: 2 leaks in the 30 days following installation and *no new leaks for the balance of 1946, 1947 and 1948!*

Cost-cutting protection such as this is being achieved with Dowell magnesium anodes. When corrosion of buried metal structures is a problem . . . for example, on oil and gas pipelines or municipal distribution systems . . . Dowell anodes may afford practical, economical corrosion control. The degree of protection will depend on soil conditions and the number of anodes used. Dowell magnesium anodes require no external power and maintenance is at a minimum.

Dowell anodes are carefully alloyed to specifications designed for peak efficiency and long life. The development of these anodes was pioneered by The Dow Chemical Company. Now, Dowell . . . a Dow Subsidiary . . . is carrying on the marketing, research and further development of magnesium anodes. Dowell can give you the technical advice to make your anode installation effective and economical. Write to Dowell for a new book containing detailed information on the uses and installation of Dowell Magnesium Anodes.

DOWELL INCORPORATED
TULSA 3, OKLAHOMA

FREE SHOWING! Now available—a new 18-minute sound slide film illustrating the possibilities of Dowell magnesium anodes for corrosion control. A Dowell representative will gladly arrange a special showing at your plant, office or organization meeting. Call or write Dowell.

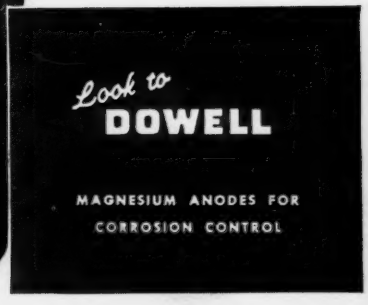


DOWELL

MAGNESIUM ANODES

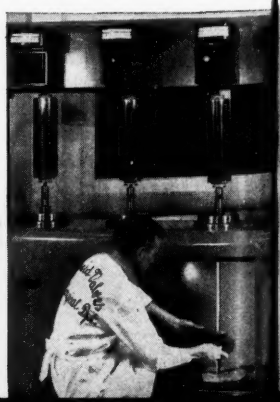
GALVO-PAK • GALVO-LINE

SUBSIDIARY OF THE DOW CHEMICAL COMPANY



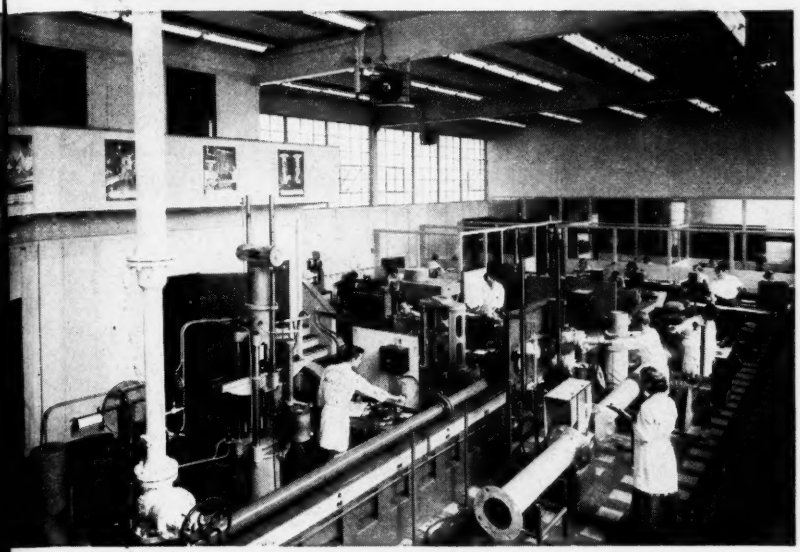
New Edward Laboratory Pledges 'F

Spacious new Edward physical and chemical laboratory at East Chicago, Indiana. Below, typical experimental units. Left, machines in background permit wide variety of hardness tests; in foreground, fatigue testing machines and polishing equipment for microscope specimens. Center, stress analysis room where effects of internal and external loads are measured with brittle lacquer and strain gages. Right, applying dead weight loads to steel test bars in stress rupture machine which records time until rupture of steel at constant load in high temperature furnaces.



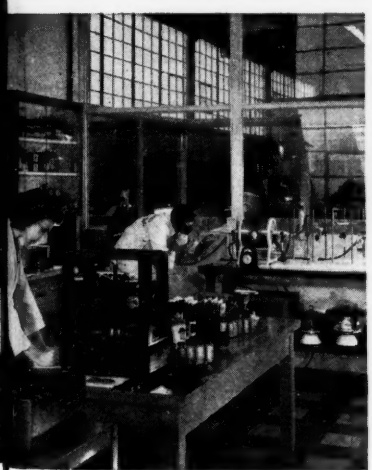
'FINEST STEEL VALVES'

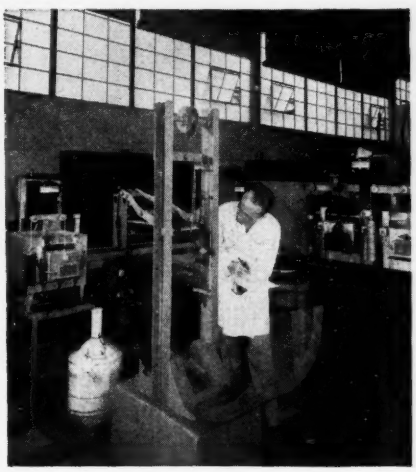
EDWARD VALVES, Inc OPENS LARGEST LABORATORY FOR STEEL VALVE RESEARCH ONLY



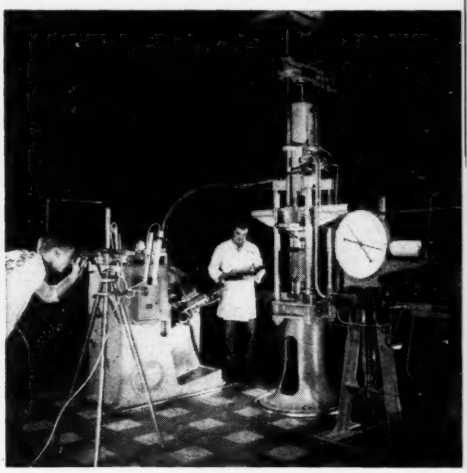
View of portion of physical laboratory. Hook-up in right foreground is for checking flow and pressure drop through experimental and actual valve designs and has guided development of new Edward valves with low pressure loss and minimized turbulence.

Metallographic room, with microscope equipment for examination of metals at high magnification, Dialatometer for the measurement of thermal expansion and phase changes, and Polariscope for stress analysis of plastic models.





Left, section of chemical laboratory with combustion train for carbon analysis of steel samples in background. Right, impact testing machine measuring energy absorbed in breaking small notched bar specimens, with furnaces for high temperature and liquid air for sub-zero experiments.



Hydraulic tensile testing machine set to measure strength of steel specimen at elevated temperatures while pulsator in background applies variable load.

To years of pioneering experience in the field of pressure-temperature piping in the power plant, petroleum and technological fields, Edward has added a large new constant temperature laboratory, dedicated to the single purpose of research into the special problems created by higher and higher design pressures and temperatures. No other laboratory devoted exclusively to steel valve research is so well equipped and staffed. For the tough jobs . . . for steel valves from ⅛ to 14 inch . . . look to Edward. From Edward you can *expect* the best.

Another ROCKWELL Product

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

EAST CHICAGO, INDIANA

WORLD'S LARGEST PENNSYLVANIA BRADFORD BREAKER INSTALLED AT SEWAREN

PUBLIC SERVICE ELECTRIC & GAS (N. J.) BUYS 4TH PENNSYLVANIA IN 25 YEARS

—ALL IN SERVICE

For many years Public Service has had the opportunity to observe the performance and maintenance of Pennsylvania Bradford Breakers. Twenty-five years ago Public Service installed a 12′ x 22′ Pennsylvania Bradford Breaker at Kearny, N. J. That breaker is still giving top performance, handling 350-400 tons of coal per hour. The same year, 1924, Public Service also installed a 12′ x 19′ Pennsylvania Bradford at Essex — *it too* is still crushing and cleaning, 325-350 TPH. At Burlington, N. J., Public Service has had a 10½′ x 17′, 500 TPH Pennsylvania Bradford-Hammermill going since 1940.

Now Public Service Company has chosen this new 600 TPH Pennsylvania Bradford to crush and clean coal for the pulverizers at Sewaren. It is always good business to invest in equipment that lowers production costs. This, Pennsylvania does in a number of ways, particularly by cleaning coal of tramp iron and debris, thus protecting pulverizers and conveyors. Send for Bulletin No. 3007.

PENNSYLVANIA CRUSHER COMPANY

DIVISION OF BATH IRON WORKS CORPORATION

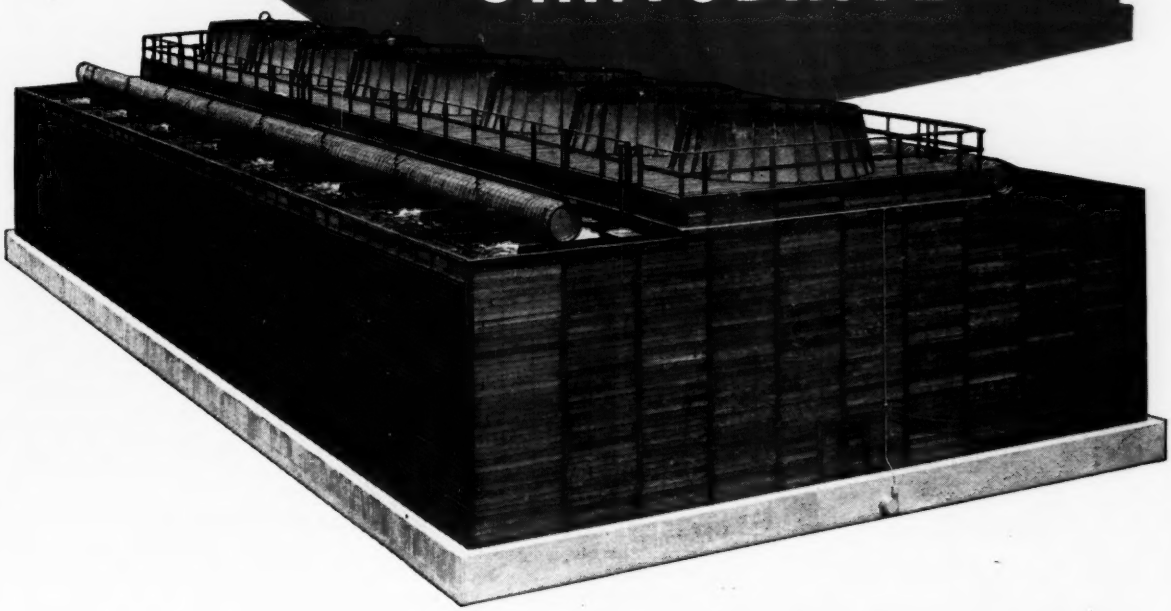
Liberty Trust Building, Philadelphia 7, Pa.

New York • Pittsburgh • Chicago • Los Angeles • Birmingham—Associated with Fraser & Chalmers Engineering Works, London

Manufacturers of a complete line of crushing equipment • Hammermills • Single Rolls • Bradmills • Kue-Ken Jaws • Kue-Ken Gyracones • Granulators • Impactors • Bradford Breakers

control SLIME and ALGAE...

SANTOBRITE



Santobrite—Monsanto's Sodium Pentachlorophenate, Technical—offers you these advantages for elimination of slime and algae in cooling water systems:

1. Maximum control of algae and slime-forming organisms.
2. Requires no special feed equipment (merely add to circulating water at any convenient location).
3. Compatible with other chemical treatments given cooling water.
4. Non-corrosive to metals.
5. Easy to apply in powder, briquettes or new dustless pellet form (for those who find Santobrite dust bothersome).
6. Readily available at reasonable cost.

Santobrite provides an economical means of maintaining peak efficiency in your cooling operations... For more detailed information, send for a copy of Monsanto Technical Bulletin O-15. MONSANTO CHEMICAL COMPANY, Desk F, Organic Chemicals Division, 1765 South Second Street, St. Louis 4, Mo.

SANTOSITE...
Controls oxygen corrosion in boiler systems

By removing all traces of residual oxygen, Santosite makes possible economical control of oxygen corrosion in boiler tubes and other steam generating equipment. For detailed information on the Santosite treatment, ask for a copy of Monsanto Technical Bulletin O-26.

Santobrite, Santosite: Reg. U. S. Pat. Off.

MONSANTO
CHEMICALS AND PLASTICS

MONSANTO CHEMICAL COMPANY
Desk F, Organic Chemicals Division
1765 South Second Street, St. Louis 4, Missouri

Please send me: ( ) Technical Bulletin O-15 on Santobrite;
( ) Technical Bulletin O-26 on Santosite for boiler feed water.

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SERVING INDUSTRY...WHICH SERVES MANKIND

NEW EQUIPMENT NEWS

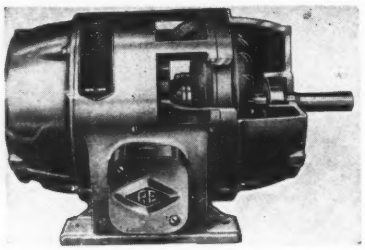
WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card, pages 35-36.

1—FLUID-SHAFT MOTORS

Feature single frame, integral design of motor and fluid drive coupling

Manufacturer reports this as the first integrally designed electric fluid-drive motor and emphasizes its savings in both original cost and mounting area. These Fluid-Shaft units utilize manufacturer's regular electric motor frames and end bells. The motors are said to offer advantages wherever loads require smooth acceleration, protection from "jamming" and shocks, or are difficult to start.

It is pointed out that loads are accelerated easily because the motor is practically up to speed before any load is applied, making possible the use of



motors closer to horsepower requirements, and saving power because of a reduction in starting current. Starting and operating shocks are said to be absorbed in a cushion of oil.

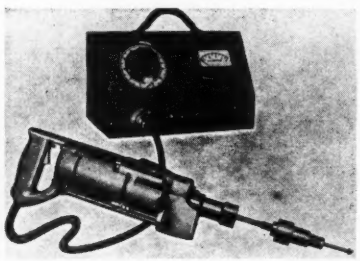
Available in standard foot mounted or round body frames. Units can be mounted horizontally or vertically or with NEMA flange and face type end bells, without special engineering. Sizes include ½ to 10 hp units in types listed. Fluid-Shaft motoreducers are available in single or double reduction types. They are intended to provide fluid-drive, electric motor and gears for slow output speeds in a compact power package. Reuland Electric Co.

2—ROLLING CONTROL

Is intended to prevent both under-expansion and over-expansion

Cold-worked stresses in metal induced by over-expansion and leakage attributed to under-expansion are said to be avoided by the Electric Tube Rolling Control, which uses mechanical means to determine the precise moment when the tube joint reaches the maximum degree of tightness. All tubes in the unit can be rolled with uniform accuracy regardless of the experience of the operator, according to manufacturer.

This expanding system consists of the control mechanism, operated with a dial



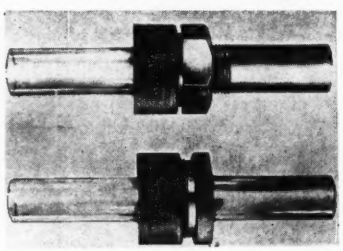
calibrated for the known expansion "peak" of each type of metal; an electric expander driving motor; and either a G-800 or G-1200 ball-bearing type condenser and heat exchanger type expander.

Operating on 110 v, 60 cycle current, the control may be plugged into any outlet; can also be furnished for d-c supply. The dial is turned to a setting pre-determined for the type of metal to be rolled, then, when maximum torque is reached, the control automatically cuts off the power, the motor reverses and the operator withdraws the expander. Airetool Mfg. Co.

3—GLASS-PIPE COUPLING

In four sizes, is designed to reduce installation time

A threaded metal coupling for use with Pyrex glass pipe lines is engineered for easy joining. Perfect alignment is said to be assured, and the danger of break-

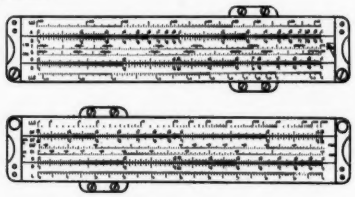


age due to uneven take-up eliminated. Installation time is reduced up to 60 per cent, according to manufacturer. These metal couplings are available from stock in ¼, ½, ¾ and 1 in. sizes for making glass-to-glass or glass-to-metal connections. Fischer & Porter Co.

4—LOG LOG SLIDE RULE

Is pocket sized, but incorporates 16-scale arrangement

Model 300 is a 6-in. duplex type, all-metal log log slide rule with the regular 10-in. scale arrangement. Described as the only such rule of its size, it is made of magnesium alloy with optical tongues and grooves machined to 0.001 in. accuracy. It has needle sharp graduations on scales optically-spaced for easy reading, manufacturer points out, to afford easy settings and computational accuracy comparable to that of 10-in. rules.



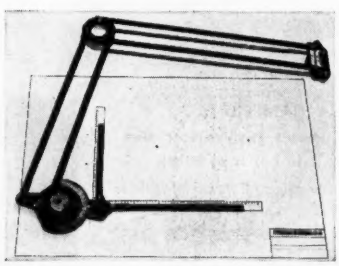
Scale arrangement is as follows: Front—LL1, A-B, T, S, C-D, LL2; Back—LL3, DF-CF, CIF, CI, C-D, L. The combination of C-D scales on both sides of rule, together with folded and reverse scales, is provided to speed figuring and avoid going "off-scale." Size is $1\frac{3}{32}$ by 6 by $\frac{1}{32}$ in. Comes in leather pocket case, complete with instruction manual. Priced at $6.75. Pickett & Eckel, Inc.

5—DRAFTING MACHINE

Is built to permit free movement of scales over drawing area

Eliminating obstructions along the top edge of the drawing area, the Model D Wrigraph Drafting Machine mounts in the extreme right hand corner of the drawing board. The machine is designed for smaller drawings and is a portable unit for the individual use of men who want to carry a machine with them for use anywhere. The drawing area is 20 by 26 in.

The ball-bearing precision drafter is accurately calibrated thru eccentric adjustments built into the mechanism. Interchangeable engine-divided scales in all of the standard graduations are available. The lightweight protractor can be locked at any angle. In two sizes both said to be low priced and guaranteed for accuracy. L. G. Wright, Inc.



USE THE NO-OBLIGATION, POSTAGE-PAID CARD ON PAGES 35-36

If it's piping for power plants

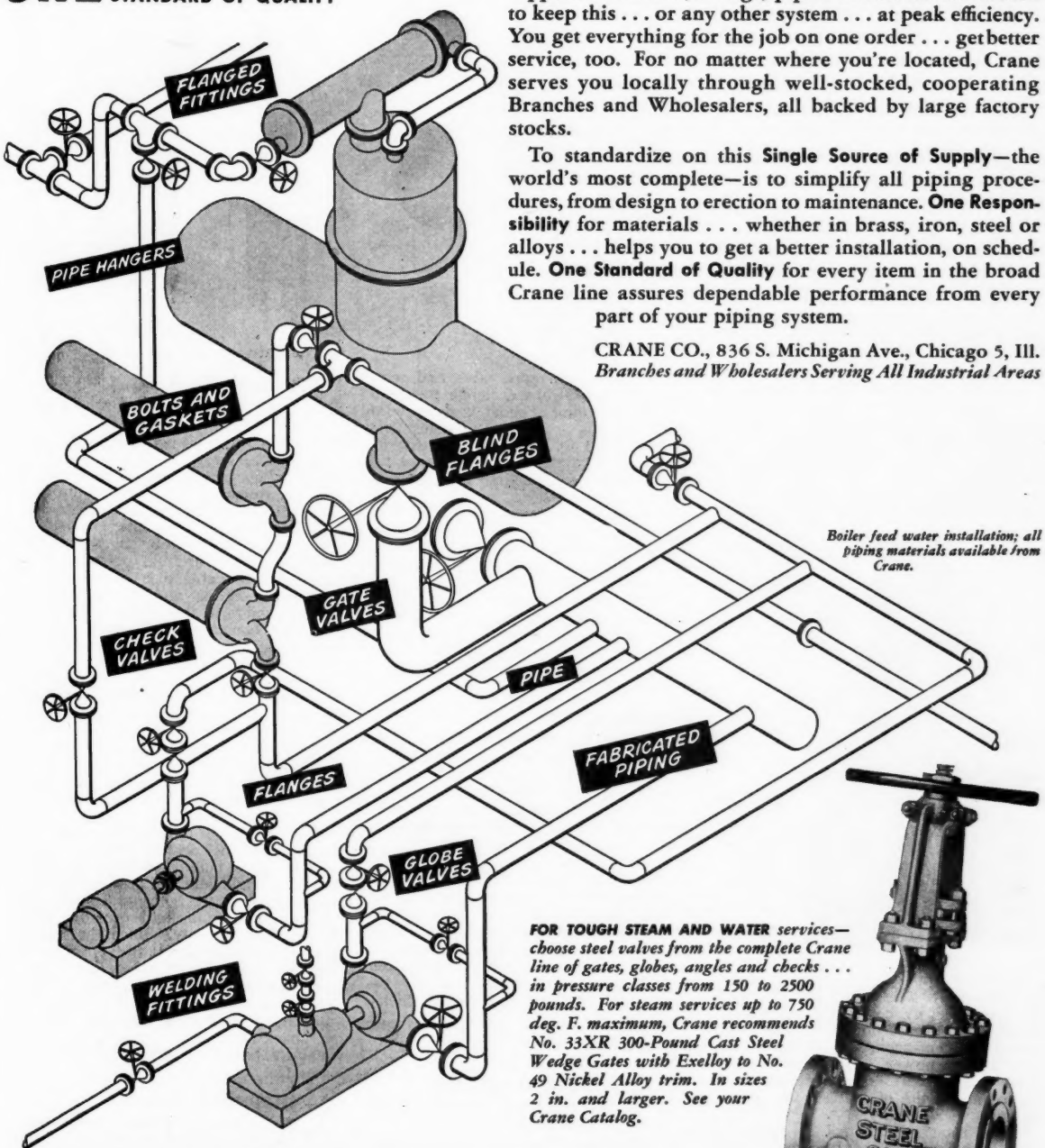
. . . It's in the CRANE line

ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

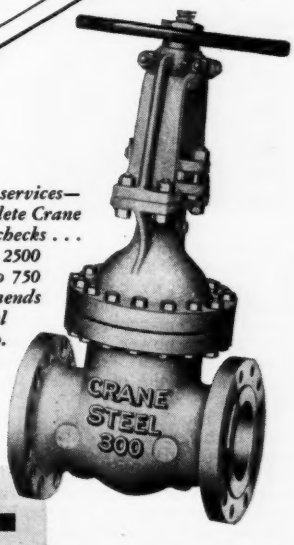
Take This Boiler Feed Water Installation, for example. Crane supplies the valves, fittings, pipe and accessories needed to keep this . . . or any other system . . . at peak efficiency. You get everything for the job on one order . . . get better service, too. For no matter where you're located, Crane serves you locally through well-stocked, cooperating Branches and Wholesalers, all backed by large factory stocks.

To standardize on this **Single Source of Supply**—the world's most complete—is to simplify all piping procedures, from design to erection to maintenance. **One Responsibility** for materials . . . whether in brass, iron, steel or alloys . . . helps you to get a better installation, on schedule. **One Standard of Quality** for every item in the broad Crane line assures dependable performance from every part of your piping system.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



Boiler feed water installation; all piping materials available from Crane.



***FOR TOUGH STEAM AND WATER** services—choose steel valves from the complete Crane line of gates, globes, angles and checks . . . in pressure classes from 150 to 2500 pounds. For steam services up to 750 deg. F. maximum, Crane recommends No. 33XR 300-Pound Cast Steel Wedge Gates with Exelloy to No. 49 Nickel Alloy trim. In sizes 2 in. and larger. See your Crane Catalog.*

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

Mark the numbers of the items you wish to receive on the no obligation, no postage card. Pages 35-36.

6—PLASTIC REFRACTORY

Is pre-mixed and shipped dry—just spread out and sprinkle with water

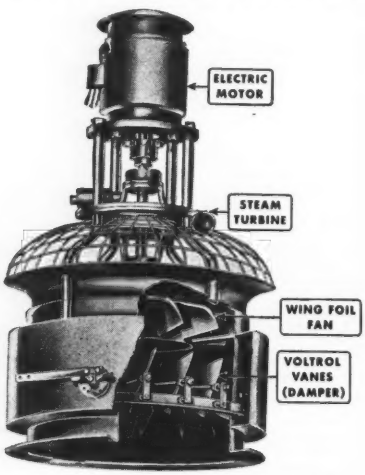
This plastic refractory, DPM (Dry Pre-Mixed) will not dry out in storage because it is shipped dry. It is pre-mixed at the factory, so no further mixing is necessary, manufacturer points out; just spread it out and add water from a sprinkling can, and it is ready for immediate use.

Available in same three grades as regular Ramtite, DPM can be stored indefinitely without special precaution, it is reported, because freezing temperatures or hot dry atmospheres won't damage it and it is always ready for emergency use. Described as ideal for ferrous and non-ferrous melting furnaces and ladles. The Ramtite Co.

7—FORCED DRAFT BLOWER

Axial flow type, features choice of electric or steam drive

This blower, incorporates a combined electric motor and steam turbine drive. A change from one drive to another can be made at will. The basic unit is manufacturer's Type R turbine blower with a totally enclosed, dust-proof



motor connected to an extension of the turbine shaft. The choice of drive may be governed by consideration of heat balance, more economical operating costs, or emergencies affecting the source of power. Operator simply throws a switch for electric drive or turns a couple of valves for steam drive.

Wide range of control is available with both drives. Throttling gives speed control of turbine and Voltrol vanes permit capacity regulation for the motor drive. Automatic operation of both drives may be arranged in connection with a combustion control system. The unit is described as extremely compact. Illustration shows vertical unit, which may be adapted to horizontal discharge by adding supporting feet. Installation is simple and economical as the packaged unit arrives completely assembled and aligned, ready to bolt to foundation. L. J. Wing Mfg. Co.

8—MAKE-UP WATER FEEDER

Is intended for use on receiving tanks of boiler return systems

Outstanding features of these feeders are the straight-thrust cam-and-roller valve action to provide tight closure against water supply pressures up to

150 psi; stainless steel valve and seat; large integral strainer, flange mounted for easy cleaning. Feeder is made with three patterns or mounting flanges. One of these will fit openings in most receiving tanks and utilize same templates and fixtures for cutting openings—as many widely used float switches.

Primary use of this water feeder will be in combination with company's pump control—a float switch located on the boiler for starting and stopping the condensation pump to maintain proper boiler water level. Manufacturer advocates this method of controlling boiler water level from the boiler itself to assure an adequate supply of water in the receiving tank. McDonnell & Miller, Inc.

9—DURIMET 20

Noted for corrosion resistance, is now available in sheet and plate

The Durimet 20 analysis was developed during the war for severe corrosive applications, the most notable and widespread of which is handling sulfuric acid. According to manufacturer of this alloy in its sheet and plate form, its importance lies in the fact that it can be applied to corrosive services formerly uneconomically handled by materials of insufficient strength or heat transfer, or by extremely high priced metals or by low priced metals with short life.

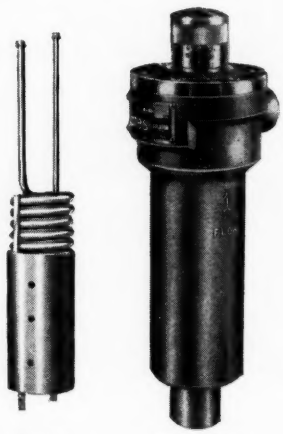
Production has started, chiefly on gages 24 to 11 and to smaller thicknesses of plate. The range is from 24 gage to ¾ in. plate. The Duriron Co., Inc.

10—BULK TANK PREHEATER

For heating of oil and other heavy fluids before they enter suction lines

The Hot-Spot Bulk Tank Preheater consists of a shell and coil assembly installed through the manhole in a bulk tank. Inlet and outlet pipes carry either steam or hot water. The suction pipe extends close to the bottom of the assembly into an oil flow accumulator which makes it necessary for the liquid to flow over the heated pipes before entering the suction line.

Load of suction pumps is relieved, it is pointed out, and the heated oil has greater Btu value. Unit is of all steel construction, tested under 500 lb air pressure. Inlet and outlet pipes furnished in required lengths for any diameter tank. Either 14 or 16 in. shell available. Rempe Co.



Preheater Regulator

11—FLUID REGULATOR

For constant control of volume flow under varying pressure

This regulator is designed to hold any pre-set flow volume constant while pressure upstream may vary over a 100 psig range. The regulating unit is in a vertical cylindrical case with valve seat and disc in a partition near its upper end. An opening in the valve disc forms a differential pressure orifice and a movable disc concentric in this orifice opens and closes a high pressure valve in the lower part of the case; thus constant differential pressure (and the flow causing it) is regulated.

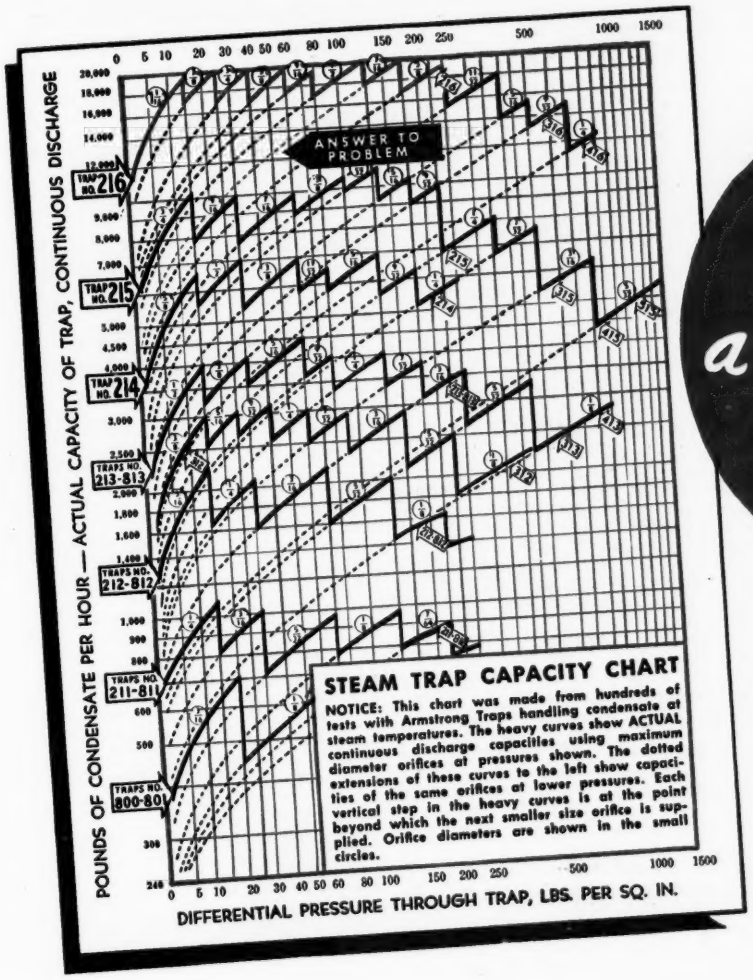
This constant differential pressure also exists across the surrounding valve, and causes constant and regulated flow through it as well. Change of the opening of this surrounding valve provides variation of flow through regulator in direct proportion to area of opening. The usual threaded valve stem adjustment thus gives a linear scale of gpm flowing.

The regulator's only moving part is the disc in the orifice and the high pressure valve connected to it. This assembly is rigid and designed to "float" vertically without restraint except by balancing forces of fluid pressure differential and gravity. Since the regulator is self-contained, the only tools required for installation are pipe wrenches and a socket wrench for tightening bonnet bolts. Regulator is applicable to fuel lines, injection, blending, backwash and rinse control in water treatment installations. The W. A. Kates Co.

12—SUSPENDED WALLS

Are universal enclosure for furnace areas, convection section of boilers

This is described as a universal suspended wall enclosure and it can be used with or without a steel casing. It is shown here as applied to water-wall boilers. It can be insulated so face temperature is reduced to 20 deg above ambient. Downcomers or feeder tubes can be concealed within the wall insulation, to eliminate unsightly piping and save on its costly insulation. All of the refractory shapes are of a modular de-


ANSWER TO PROBLEM
TRAP NO. 216
TRAP NO. 215
TRAP NO. 214
TRAPS NO. 213-813
TRAPS NO. 212-812
TRAPS NO. 211-811
TRAPS NO. 800-801
STEAM TRAP CAPACITY CHART
NOTICE: This chart was made from hundreds of tests with Armstrong Traps handling condensate at steam temperatures. The heavy curves show ACTUAL continuous discharge capacities using maximum diameter orifices at pressures shown. The dotted extensions of these curves to the left show capacities of the same orifices at lower pressures. Each vertical step in the heavy curves is at the point beyond which the next smaller size orifice is supplied. Orifice diameters are shown in the small circles.
POUNDS OF CONDENSATE PER HOUR — ACTUAL CAPACITY OF TRAP, CONTINUOUS DISCHARGE
DIFFERENTIAL PRESSURE THROUGH TRAP, LBS. PER SQ. IN.
0 5 10 20 30 40 50 60 80 100 150 200 250 500 1000 1500

BECAUSE good trapping starts with selection of the right trap for the job, Armstrong has provided all the data necessary for correct trap selection in the Armstrong Steam Trap Book. The Capacity Chart reproduced here is taken from this handy reference work. By means of this chart, any engineer can select the correct traps for his requirements. Here is a typical problem showing how the chart is used:

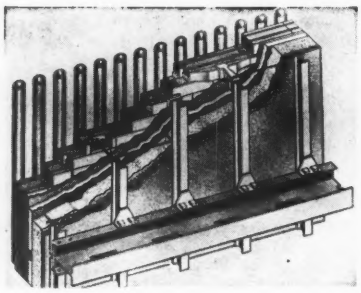
Given: An evaporator condensing 6000 lbs/hr at 50 psi when the steam is first turned on, but condensing only 1000 lbs/hr at 150 psi at the end of the process. Safety factor of 2 to 1 required at the *minimum* pressure differential.

Solution: Referring to the chart, the No. 216 Armstrong Trap with 7/16" orifice for 150 psi pressure has a capacity of 12,000 lbs/hr at 50 psi. This provides for the 2 to 1 safety factor and is, therefore, the correct trap for the job.

The Armstrong Steam Trap Book provides recommended safety factors for different services and handy tables to help you calculate condensing rates. Other useful data included are: hook-up diagrams; do's and don't's; trouble-shooting tips; prices and specifications. You're welcome to a copy. **ARMSTRONG MACHINE WORKS, 810 Maple Street, Three Rivers, Michigan.**

ARMSTRONG *Quality Built* **STEAM TRAPS**

For fuel savings, low maintenance, automatic air removal SPECIFY ARMSTRONG!



sign, the refractory thicknesses being 3 in. and 4½ in. Wall may also be furnished with a metal casing for outdoor service. Geo. P. Reintjes Co.

13—AIR PRESSURE GAGE

For permanent or temporary installation in any position

The Magnehelic Gage is said to be extremely sensitive. According to the manufacturer, it is unusually efficient in checking furnace draft, testing filter resistance in ventilators and air conditioning equipment, measuring static pressure and air deliveries of fans and blowers, air velocity measurement from 400 fpm to 10,000 fpm, and checking the operating efficiencies of dust collectors and processing systems.

The gage uses a flexible diaphragm supported by a cantilever spring carrying a magnet actuating pointer assembly. Vertical motion of the diaphragm is transformed to rotary pointer motion by a helical magnet linkage. The action is described as frictionless, as the force of the magnet causes the helical assembly to assume a position in which magnetic force can travel through a minimum air gap. Motion of the magnet as small as ¼ thousandth of an inch are reflected in minute movements of the pointer, it is said.

Plus, minus and differential readings are available. The range is 0-½ in. to 0-12 in. of water. Manufacturer states that the gage is not a delicate instrument and no special precautions are necessary in using it. It appears to be ideal for installation on flow meters, control equipment, automatic valves, gas-air ratios. All types of connections are possible—rubber tubing, ⅛ in. pipe thread or ¼ in. copper tubing. F. W. Dwyer Mfg. Co.

14—FLASHOVER INDICATOR

Signals when insulator flashover occurs on transmission tower

When a pole is struck by lightning or any flashover occurs, a cartridge within this indicator explodes and releases a beaded yellow flag that may be seen from a long distance during the day, or at night by spotlight. Indicator is mounted on the pole—either metal or wood—and connected to the ground by an insulated wire running to a separate driven ground rod about 2 ft long.

Use of a separate ground rod is said to provide more than enough potential so that flashover of any kind, either lightning or power, produces enough voltage across the power capsule to explode the capsule and drop the target. It is pointed out that with these indicators patrol costs can be greatly reduced by the use of air-borne patrols and binoculars. Beaman Plastic Products Co.

15—PISTON RING PACKING

Is developed for inside-packed reciprocating pump service

Palmetto Pisto-Rings are molded to size and are easily installed without special tools, according to manufacturer, who adds that they are flexible and won't crack and are impervious to boiler feed water, salt water, fuel oil, lubricating oil, gasoline, brine, alcohol, most acids and alkalis.

These packings do not shrink or swell in service, it is said, are heat resistant up to 450 F, and are self lubricating. Recommended as applicable for all inside-packed piston packing, Pisto-Rings come in 16 sizes from 5¼ in. OD and 3¾ in. ID to 14 in. OD and 12½ in. ID. Widths range from $\frac{1}{32}$ in. to ¾ in. Special sizes are obtainable. Greene, Tweed & Co.

16—TEST PAPER SET

For differentiating between various types of alkalinity

This test set employs a series of new test papers for differentiating between caustic alkalinity, carbonate alkalinity and bicarbonate alkalinity of water and solutions. It is expected to find wide use in chemical manufacturing, power plants, process industries and any place where it is necessary to control the alkalinity of treated water. A compact and inexpensive kit consists of three vials of selected indicator papers. Complete instructions are printed on the box. Lamotte Chemical Products Co.

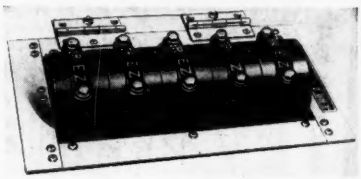
17—PLATE MAGNETS

Permanent, non-electric type are now stronger and lighter

Redesign of manufacturer's complete line of permanent non-electric Standard and Jumbo plate magnets has resulted in a 50 per cent increase in magnetic strength and a 30 per cent decrease in weight, it is reported. Previously noted for their strength, these magnets now offer greatly increased magnetic protection at no increase in price, manufacturer states, adding that their lighter weight and compact construction will permit easier installation in less space.

Magnets consist of a series of Alnico castings designed to obtain great external energy. Improvements are credited to efficient design, newly developed Alnico material and new charging techniques. These magnets are intended to remove tramp iron from materials traveling in chutes and spouts or in pneumatic lines and to provide protection for machinery, guard against fires and explosions and eliminate ferrous metal contamination.

Both models are available for installation in metal or wooden chutes, feed

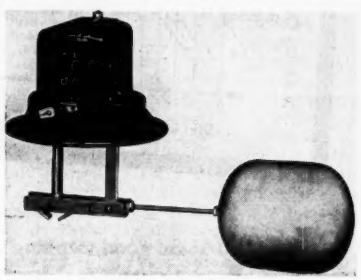


tables, hoppers, with or without hinges. Sizes range from 4 to 72 in. wide in increments of 2 in. Larger units and special shapes available. Magnetic strength will last indefinitely, it is claimed. Eriez Mfg. Co.

18—TANK FLOAT SWITCH

For automatic control of liquid level within closed tanks

No. 9037 Type EG tank float switch for condensate pumps is flange mounted; it is described as especially applicable to vertical mounting but may be mounted horizontally as well. Adjustments permit contacts to open or close on



liquid rise in either position, according to manufacturer, who points out that without removing the switch from an installation, float travel may be adjusted within moderate limits by removing cover and adjusting two lock nuts. Switch is designed to function properly under a pressure of 25 psi.

Stationary contact block and movable contact yoke bar are made of non-carbon tracking melamine. The structure is two pole, double break, silver to silver, visible and vertical contact. The operating mechanism is of the positive snap-action toggle type to assure operation even when liquids are turbulent.

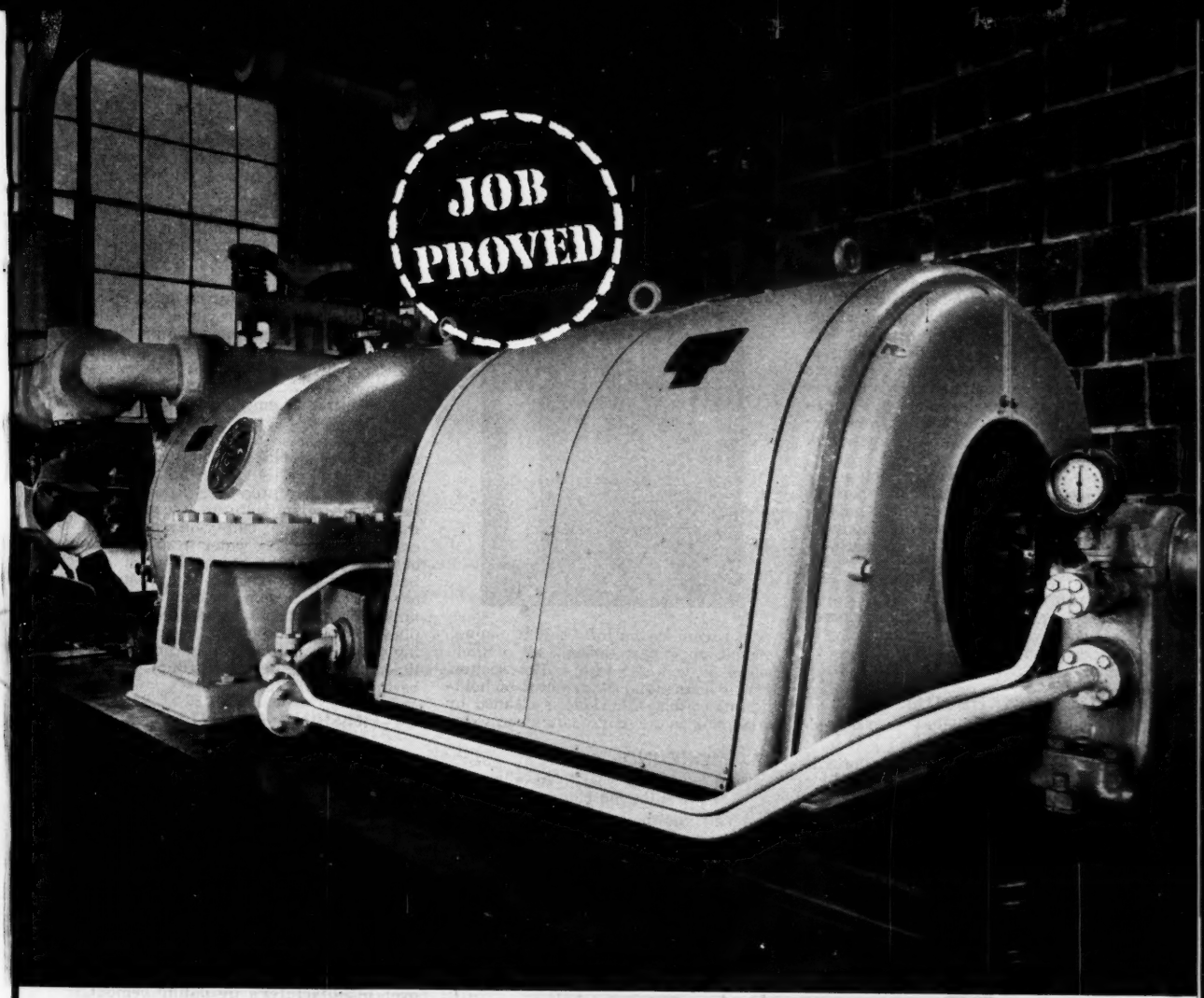
Enclosure consists of a steel frame with a slip-on steel cover finished in blue-gray enamel and built to NEMA No. 1 specifications. A watertight seal is said to be insured by a graphite coated asbestos, used in the stuffing box. Square D Co.

19—AIR BREAK CONTACTOR

Is compactly designed unit for high voltage service

Type 256 contractor is only 15 in. wide, 25 in. deep and 38 in. high, but adequate insulation has been provided between all live parts and ground and mechanical sturdiness has not been sacrificed,

Mark the numbers of the items you wish to receive on the no obligation, no postage card. Pages 35-36.



CORROSION THREAT ENDED BY SUNVIS 916

Turbine Under Intermittent Operation Gets Year 'Round Protection

A utility company serving an island summer resort operates an auxiliary turbine at peak capacity throughout the vacation season. But for the rest of the year, this equipment is shut down and corrosion is a constant threat. An oil is required that will keep the equipment running under the heavy summer load, and maintain it ready for instant use in case an emergency should arise during the off season.

More than two years ago, acting on the advice of a Sun engineer who had been consulted, the company filled the circulating system of its turbine with Sunvis 916 Oil. The unit is still running on the original charge and inspection shows complete absence of corrosion.

There has been no perceptible wear of parts. The Sunvis 916 Oil is in excellent condition and only slight make-up has been required to take care of normal leakage.

This is but one of many examples of how "Job Proved" Sunvis 900 Series Oils protect vital and expensive machinery. They are highest-quality, solvent-refined oils, specially manufactured to resist oxidation and sludging, and to protect metal parts against rusting and corrosion. For a copy of the illustrated booklet "Sunvis 900 Oils," write Department PN-10.

SUN OIL COMPANY · *Philadelphia 3, Pa.*
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SUN PETROLEUM PRODUCTS

"JOB PROVED" IN EVERY INDUSTRY

SUNOCO

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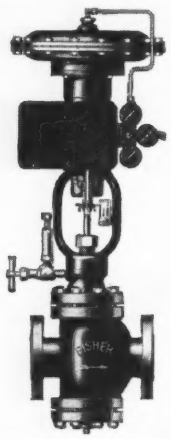
according to manufacturer. The contactor has double break contacts to halve the arc voltage and double the rate of dielectric recovery; also a vertical direct action solenoid type magnet. Self-centering movable contacts are provided to assure positive closing of both contact gaps. Gap and pressure adjustment is accomplished by a threaded connector. Arc chutes are of a material developed to withstand high arc temperatures and prevent production of arc supporting gases.

Three principles of arc extinction are incorporated in contactor; two breaks in series, magnetic blowout, and increasing length of arc path horizontally and vertically. Available with mechanical and electrical interlocks for reversing or dynamic breaking service. Manufacturer's high voltage motor starters equipped with oil immersed contactors will now be augmented with starters having Type 256 air break contactors. Allis-Chalmers Mfg. Co.

20—VALVE CONTROLLER

Is designed to insure correct positioning of control valve

The Positrol is intended for automatic control installations where control valve does not position itself. Simple in design, it consists of a few levers, a bel-



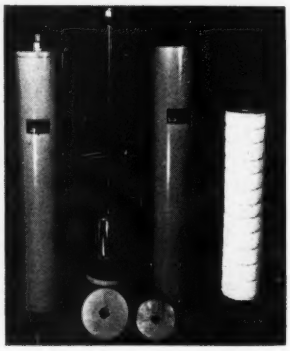
lows unit and a spring. Valve travel is adjustable between ¼ in. and 3 in. The Positrol is a force balance type valve controller and is available with or without by-pass and may be used as a remote position indicator. It is described as compact, rugged in construction, accurate and dependable. Fisher Governor Co.

21—CONDENSING FILTER

For instrument air service, it filters and dehydrates

In addition to filtering and dehydrating air, the Condensifilter automatically discharges condensed vapors. Illustration shows unit assembled, at left, and components, at right. Outer case is 8 in. steel pipe 51 in. long. Air is admitted at bottom through center shaft and is directed into condensing section where it must pass over 68 ft of ⅜ in. OD copper tubing through which cooling water is circulating. Inlet and outlet connections are in bottom head.

Water and oil condensed out of the air drop into discharge section where a snap-action trap causes unit to blow down when condensables have accumulated. From condensing section air travels upward to filter cartridge which consists of five concentric filter baskets nested together. Each basket is wrapped

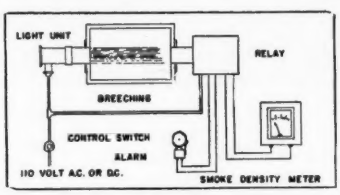


with seven layers of Canton flannel, and air must pass through all of them before it can get into outlet section. Unit is dismantled by removal of holding nut at top. Cartridge is cleaned by immersing in solvent. Hankinson Corp.

22—SMOKE INDICATOR

Is heavy-duty unit for use with steam jets over the fire blower

Designed for boiler room service, to register smoke density, the improved McNeil Smoke Indicator has an easy-to-read density meter and flush panel construction. It is compact and easily

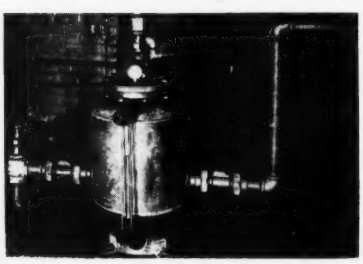


installed and serviced, according to manufacturer, and the 4-in. lens is readily removable for cleaning. Unit can be used on a 15-ft span of breeching. The recorder can be added at any time. Trimount Instrument Co.

23—CYCLING JET PUMP

Lifts by suction and discharges against heads equal to pressure used

The ability of this pump to lift by suction and discharge against heads of approximately equal to the gas, air or steam pressure used for operation is credited to a two-part cycle which con-



tinues automatically until pump is turned off. The pump consists of a receiver tank, float-controlled operating valve, ejector, piping, gages and valves. Only moving parts are the float-controlled valve and two check valves.

When pump is turned on with receiver empty, the float is in lowest position. The gas, steam or air is directed into ejector, creating a vacuum in receiver. Liquid to be pumped is drawn into receiver. As it fills, the float rises, ultimately closing control valve to divert gas pressure from ejector to receiver. This reverses pressure in receiver, creating a positive pressure. The check valve in inlet closes and the check valve in outlet opens. Gas pressure now forces liquid out of receiver and when it is empty the float again actuates ejector.

Two-in. size is available from stock and can be modified to suit conditions as capacity varies according to discharge and gas pressure. Applications for which manufacturer recommends this pump include: emptying sumps and excavations; raising water from streams or containers to fill elevated tanks and boilers; injecting chemicals into vessels or fluid lines; recirculating fluids in tanks for agitating; transferring fluids; pumping fluids through process or treating vessels; pumping in hazardous locations, and pumping viscous fluids. Penberthy Injector Co.

24—FINISHING CEMENT

Is developed for faster application on indoor or outdoor jobs

Said to eliminate from three to six standard application steps, Powerhouse Finishing Cement is described as a dry, loose material of mineral wool fiber base, with a thermal efficiency superior to that of asbestos finishing cements, and approaching that of insulating cements.

It is said to apply easily with a trowel, have unusually low shrinkage, and resist temperatures up to 1700 F. This product was developed for application over manufacturer's insulating cement, but may be applied over any thermal insulating block or plastic insulating cements. Through its hydraulic set Powerhouse develops a strong, resilient surface, manufacturer states that Powerhouse can be stored indefinitely and applied under adverse weather conditions, and is easily maintained in service.

Reputed to be an ideal finishing cement for boilers, breechings and ductwork, oil refinery towers, vulcanizers, kilns and turbines. It is adaptable to both irregular small surfaces and large flat areas. Baldwin-Hill Co.

25—PROTECTIVE COATING

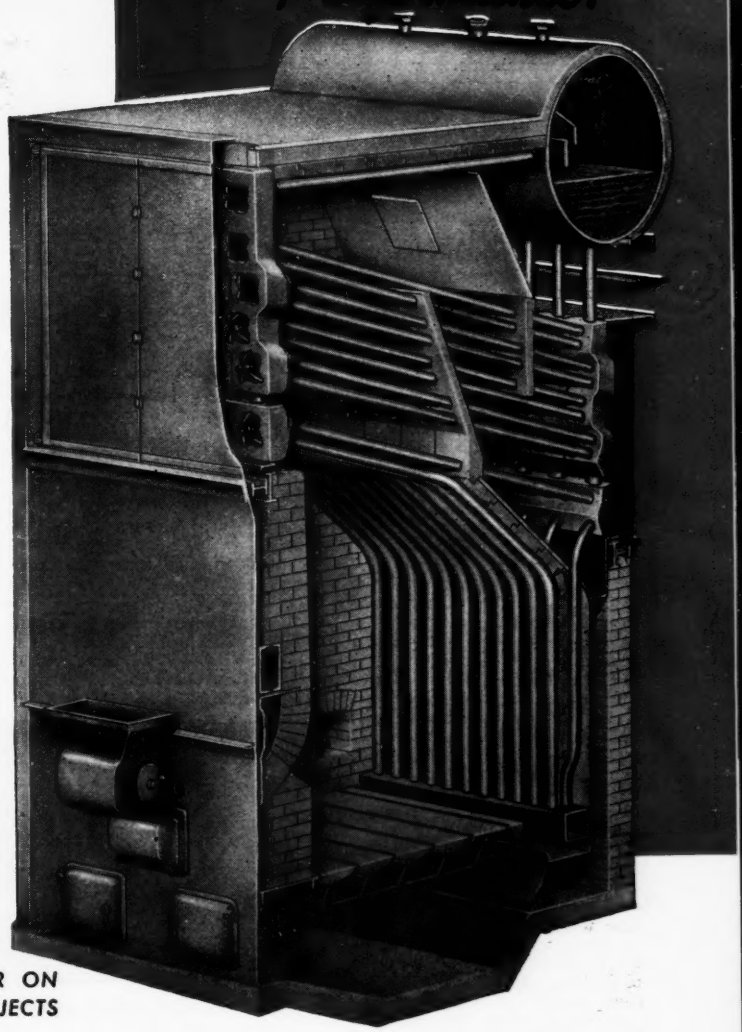
A self priming vinyl-base paint, it adheres to wood, metal, concrete

Tygon Series K self-priming paint was developed primarily as an easily-applied protective coating to resist corro-

SPRINGFIELD *Standardized*

TYPE MC COAL FIRED BOILERS

Built TO "BIG PLANT" STANDARDS OF Performance!



Choice of Sizes —Here is Springfield's new *Standardized* Type MC boiler. Available in a wide choice of sizes to help you meet small to medium size steam plant needs with minimum delay and less capital investment.

Standardized Construction — Boilers are assembled from same component parts. Height and depth are standardized. Width varies according to number of sections used.

Coal, Oil or Gas Firing — Designed for coal firing with standard stokers. Equally adaptable to high efficiency firing with standard oil or gas burners.

Quicker Delivery — Stocks of parts are maintained for prompt assembly and shipping of units. For information on delivery, see your local Springfield representative, or write.

CHECK WITH YOUR CONSULTING ENGINEER ON YOUR MODERNIZATION AND NEW PLANT PROJECTS

SPRINGFIELD PRODUCTS

BENT TUBE STEAM GENERATORS—Modern designs for capacities from 10,000 lbs. up.

STRAIGHT TUBE BOILERS—Specially designed for capacities from 5,000 to 450,000 lbs. per hour and higher.

STANDARDIZED TYPE M BOILERS—Standardized for quicker delivery and lower cost. Sizes 7,500 to 17,000 lbs. per hour.

WATER COOLED FURNACES—Heavy duty water walls. Exclusive center water wall construction for larger units.

SUPERHEATERS — AIR HEATERS — ECONOMIZERS—Individually designed to meet requirements.

BOILER No.	510	610	710	810	712	812	912	1012
Steam Capacity, Lbs. per Hr., continuous	7,500	9,000	10,500	12,000	12,500	14,300	16,000	17,800
Heating Surface, Sq. Ft.	895	1,077	1,256	1,430	1,490	1,703	1,918	2,128
Furnace Volume, Cu. Ft. Oil or Gas	305	360	415	475	550	625	700	775
Stoker	270	320	370	424	485	555	620	690
Furnace Width	4'7½"	5'6"	6'4½"	7'3"	6'4½"	7'3"	8'1½"	9'0"
Overall Width	8'2½"	9'1"	9'11½"	10'10"	9'11½"	10'10"	11'8½"	12'7"
Overall Length	11'11¼"	11'11¼"	11'11¼"	11'11¼"	13'10¼"	13'10¼"	13'10¼"	13'10¼"
Overall Height	19'4"	19'4"	19'4"	19'4"	19'4"	19'4"	19'4"	19'4"
Furnace Depth	7'10"	7'10"	7'10"	7'10"	9'7"	9'7"	9'7"	9'7"
Steam Outlet Size	4"	6"	6"	6"	6"	6"	6"	6"
Feed Inlet Size	1½"	1½"	2"	2"	2"	2"	2"	2"
Blow Off Size	2"	2"	2"	2"	2"	2"	2"	2"

SPRINGFIELD BOILER CO.

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sive conditions not sufficiently severe to warrant the use of manufacturer's multiple coat paints. For normal conditions two to three coats of Series K are recommended to provide effective and long-lasting protection. Paint may be brushed or sprayed; it air-dries quickly or it may be baked.

Series K is described as showing excellent resistance to corrosive fumes of almost all acids and alkalies; as well as to excessive humidity, grease, oil, and alcohols. It is softened by aromatic hydrocarbons, ketones and esters. Non-oxidizing and non-inflammable when dry, it possesses an upper temperature limit of approximately 200 F. Available in black, white, clear, gray, red, green and aluminum. The U. S. Stoneware Co.

26—AUTOMATIC LOCKING NUT

Is made to lock securely in any position on threaded part

Positive locking, exact adjustment, quick application and economy are features claimed for the Locknut. It consists of a standard steel nut and a slightly elliptical retainer ring combined in a single unit. When applied, the bolt forces the heat-treated alloy steel retainer back into circular shape, causing retainer to grip bolt threads with high pressure and preventing rotation of nut even under conditions of severe vibration.

Manufacturer says automatic locking of the nut on the bolt doesn't require bolt tension; it stays where it is positioned by wrenching. The nut can be applied in either direction. When retainer grips the bolt on which the nut is applied, bolt load or stress is borne entirely by the nut.

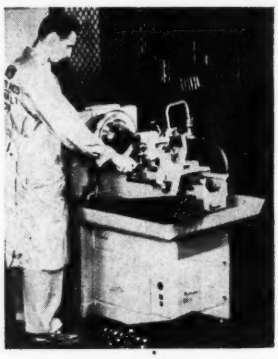
Position of nut on threaded portion of bolt or other threaded part can be readjusted at any time, and nut may be removed and reapplied. High temperature tests are said to have shown no effect on nut's holding power, and vibration tests have led to standardization of Security Locknuts for Diesel locomotives, power shovels, tractors, pumps and compressors, forging hammers, punch presses, conveyors and other equipment. Made with National coarse and fine threads in standard sizes from ⅜ to 2½ in. The Security Locknut Corp.

27—THREADING MACHINE

Has speed selector switch, push-button controls for standard voltages

The No. 702 Wilco has a regular pipe range of ¼ to 2 in.; extra pipe range of ⅛ in., and bolt range of ¼ to 1½ in. Faster threading and minimum handling of stock are credited to the three-speed motor (900-1800-3600 rpm and spindle speeds 40-80-160 rpm); worm gear drive with ball bearing mounted spindle; wrenchless front chuck; non-locking rear centering chuck; quick-opening adjustable die heads with segmented dies; length gage for threading and calibrated gage for setting to desired length for cutting-off; individual drive centrifugal coolant pump.

Manufacturer points out that the versatility of the machine is demonstrated by its ability to thread short lengths of pipe on both ends without using a nipple chuck. Carriage and die head support the operating unit with flat ways on bed. A carriage operating lever is used instead of handwheel. Carriage travel is 12 in.; length of ways

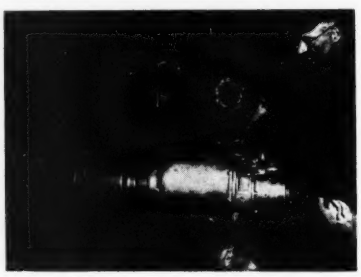


30 in.; spindle bore 2½ in.; height to center of spindle 38 in. Maximum length of thread cut without regripping stock is 14½ in. Floor space required 2 ft 3 in. by 5 ft 10 in.; overall height 3 ft 11½ in.; net weight 1650 lb. The Oster Mfg. Co.

28—AIR IMPACT TOOL

For extremely heavy bolting-up jobs, is rated up to 4-in. bolt size

The Slugger, Size 588 impact tool is described as the largest of its type manufactured. Capable of handling both maintenance and production work, it is designed especially for speedy repair of heavy equipment and other applications involving large studs, bolts and nuts.

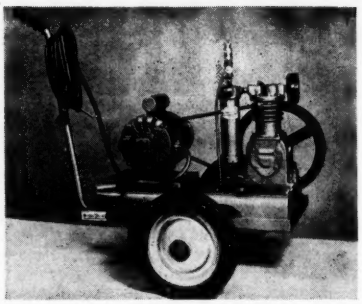


This impact tool weighs 215 lb and has free speed of 355 rpm, with 550 impacts per min. Overall length to shoulder of anvil is 26⅝ in.; side to center of hammer case is 4 in. Tool operates with a 2½ in. square driver. Standard equipment includes a safety live air handle with independent reverse, suspension ring and dead handle. Ingersoll-Rand Co.

29—PORTABLE COMPRESSORS

Piston type, offer two working pressures and two air deliveries

One of these air compressors, Model B-140-DS, is powered with a ½ hp electric motor; the other, Model G-140-DS, is powered with a ¾ hp gasoline engine. Both operate at 150 lb pressure delivering 2.4 cfm free air for tire inflation, operating a grease gun, air blow gun or other uses requiring high pressure. By shifting a lever, the compressor is a continuous-running unit at 50 lb pressure delivering 3.2 cfm free air for paint spraying, insecticide spraying and other applications requiring low pressure and increased volume.



Both models are adaptable where quick, dependable performance is needed at low cost, it is stated, and both are easily portable with or without cart. Electric powered compressor mounted on a portable two-wheeled rubber-tired cart is $115.60; gasoline model, similarly mounted, is $119.90. Kellogg Div., American Brake Shoe Co.

30—MAGNET MATERIALS

Two permanent Alnico types offer improved magnetic properties

The development of two permanent magnet materials, Alnico 5DG and Alnico 7, is announced. Alnico 5DG is a modification of Alnico 5, in which the crystal structure of the magnet is aligned in the direction of magnetization. The letters DG refer to directional grain. A change in the manufacturing process made this new structure possible. As a result, manufacturers who use permanent magnets may now use smaller size magnets. This in turn makes possible a reduction in the size of the magnetic frame and corresponding cost reduction, and lower equipment weight.

Alnico 5DG will provide manufacturers of magnetic separators, motors, instruments, and other industrial products with the highest external and residual induction of any permanent magnet material known today, manufacturer states.

Alnico 7 has been developed for applications where a high demagnetization force is present, as in motors, generators, and variable air gap devices. This new magnet is said to show a higher coercive force than any other grade of Alnico. General Electric Co.

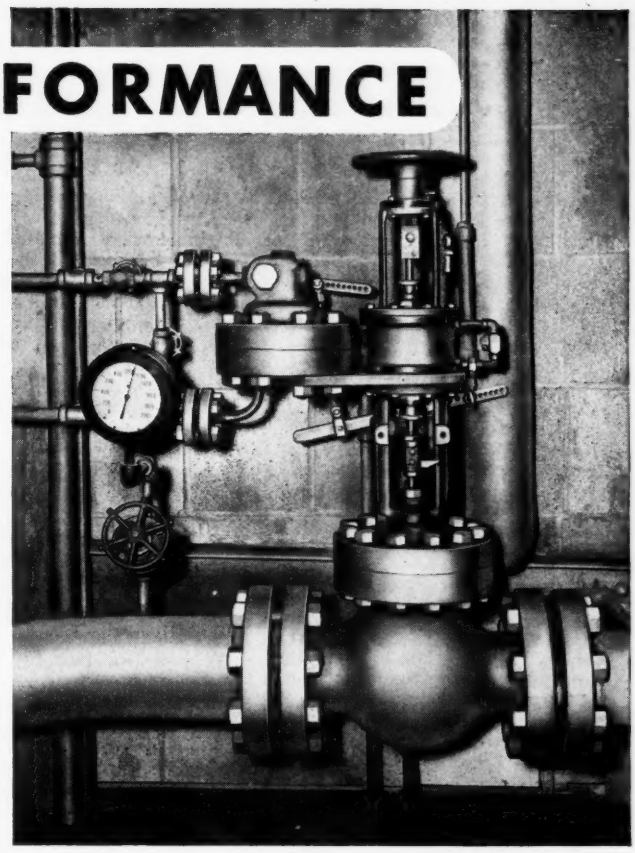
31—WEATHERPROOF SWITCH

Is externally operated, designed for outdoor use

This new device was primarily designed for use on buildings requiring a 30 amp. capacity service entrance switch in combination with four plug fuse branch circuits. Two styles are available, R33NP4 with two main plug fuses and R33NU4 without provision for main fuses. Both have a 1 in. hub. A raintight cabinet is provided to protect the interior mechanism, so the switch has many applications for either temporary or permanent outside installations.

Access door for branch circuit lighting fuses provides dead front. The dead front cover is hinged at top and provided with means for holding the cover in the open position to facilitate wiring and replacement of main fuses. The spring catch front cover can be sealed. Adequate clearance is provided to accommodate branch fuses of the non-tamperable type and the spring catch on the panel door may also be sealed. General Switch Corp.

3-YEAR PERFORMANCE *Sold* 3 MORE FLOWMATICS *at* CALCO



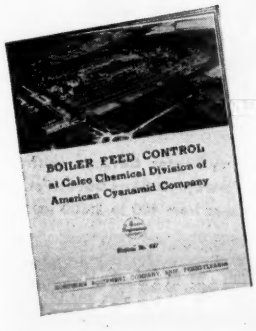
Installed in 1942 at the Bound Brook, New Jersey, plant of the Calco Chemical Division of American Cyanamid Company, this COPES Flowmatic Regulator gave good results from the start—even before combustion was under fully-automatic control—on the 900-psi Riley Type RP boiler rated at 200,000 pounds of steam per hour.

Three years later, Calco installed three more COPES Flowmatics to replace another type of feed water regulator on three older 480-psi boilers, each with maximum capacity of 100,000 pounds per hour. Only routine maintenance has been needed to keep all four COPES Flowmatics giving optimum performance since installation.

COPES Flowmatic Control gives you close control of boiler water level, regardless of range or speed of load fluctuation. Entirely indepdendent of instruments and other controls, it remains on full automatic during periods when they must be out of service for periodic maintenance. Simple and rugged, it handles emergency conditions as safely and dependably as it does normal operation.

These are the reasons why COPES Flowmatics have been ordered for more than 2800 boilers with pressures up to 1825 psi. Why you will find users in all of the 48 states and in 43 other countries. Why operation of your modern high-duty boilers will be safer and more efficient with two-element COPES Flowmatic Control—designed and built for your individual requirements, to fit any piping layout and operating preference.

NORTHERN EQUIPMENT COMPANY
1092 GROVE DRIVE • ERIE, PENNSYLVANIA
BRANCH PLANTS in Canada, England, France, Austria, Italy
☆ *Representatives Everywhere* ☆



The story of COPES at Calco is told in Performance Report 481. Write for your copy—on your letterhead, please

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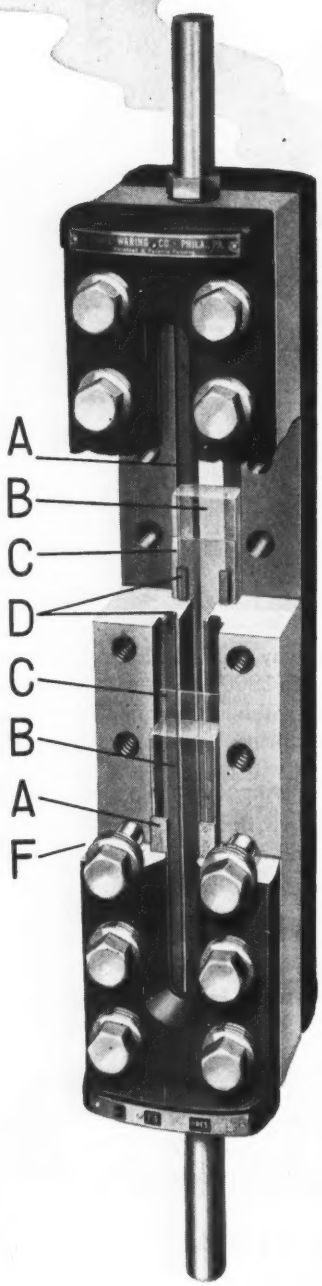
"Floating Assembly" Water Gage

REDUCES LEAKAGE and GLASS BREAKAGE



Yarway offers help to the steam plant engineer who has the problem of leakage and glass breakage on flat glass water gages. It's "floating assembly."

Research shows a flexible feature is required to prevent leakage and excessive loading of glasses. *Spring cones (F), under the cap nuts fastening independently adjusted covers and glasses in place, provide this flexibility.* The "floating assembly" loading is predetermined . . . is maintained by cap screws which shoulder on the insert body, limiting the spring cone compression to that required. *Front and back cover plates are independently adjusted.*

Engineers say these features help them. They may help you, too.

For the full story on "floating assembly" and the Yarway line of water columns and gages, send for Bulletin WG-1811. Or see a model demonstrated in your own plant. Write . . .

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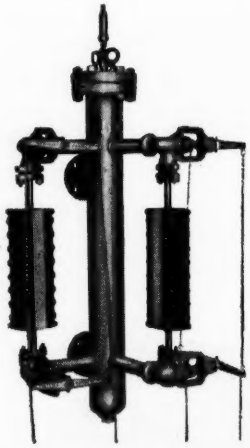
Cut-away section of Yarway Flat Glass Gage. Front and back cover plates are independently fastened to body by special shouldered cap screws fitted with spring cones (F) which automatically limit the pressure on glasses and gaskets and at the same time allow for expansion and contraction.

Special molded gaskets (D) provide tight pressure-sealed joints between body and glasses. Cushioned asbestos gaskets (A) are placed between cover plates and outer faces of glasses (B). Inner surfaces of glasses are protected by India ruby mica (C).



Yarway Water Column with two Yarway Flat Glass Gages. For pressures from 400 to 2,500 psi.

YARWAY

WATER COLUMNS AND GAGES

LETTERS TO THE EDITORS

ECONOMIZER RE-DESIGN

Following are excerpts, by permission, from two letters recently written by Mr. Derby to J. B. Cotter, Superintendent, Grand Tower Power Station, Central Illinois Public Service Company, author of the article, Economizer Re-design Stops Leaks, Cuts Maintenance, Boosts Efficiency: *Power Plant Engineering*, May, 1947, page 76. Mr. Derby recounts a similar problem and its solution, the same in principle but differing in a few details from Mr. Cotter's. Readers will also be glad to learn that Mr. Cotter's paper won a first award in the James F. Lincoln Welding Foundation contest last year. Further comments are invited from readers on both Mr. Cotter's and Mr. Derby's re-designs and re-building.

DEAR MR. COTTER: We have recently had occasion to read your informative article in the May 1947 issue concerning the re-design of the 7,080-sq-ft, straight-tube economizers, in your plant. Your comments were of particular interest to us inasmuch as we have just experienced similar leakage difficulties, at the plant of one of our clients, with economizers of the type you describe as being originally installed.

The economizers with which we have had our experience contain 1830 sq ft of heating surface, with the tubes arranged 43 tubes high and 8 tubes wide. All tubes were straight, No. 10 ga 2 in. in diameter and 9 ft-10 in. long, and were rolled, at each end, into 7¼-in. square seamless steel headers.

The units are installed on boilers of 50,000 lb per hr capacity which operate at steam conditions of 475 psi and 750 F at the superheater outlet. The flue gas enters the top of the economizer and the feedwater at the bottom. The temperature of the entering feedwater is normally 218 F, and the temperature of the gases leaving the economizer is in the range of 380-390 F.

Corrosion Found in Economizer

Following the discovery of leakage, an inspection of the economizer tubes revealed that they were badly pitted and eroded at several points very close to the headers. This condition appears to correlate very well with the one that you observed, and may have been caused, as you state, by expansion strains, which loosened the rolled joints in the headers and resulted in leakage along the tube. When the water came in contact with the fly ash on the tube surfaces, a detrimental chemical action resulted.

In addition to the condition noted above, our inspection revealed that nearly all the tubes in the economizer were encased by a bitumastic-like scale, approximately 1/16-in. to ⅛-in. thick. This coating was of such a nature that it could only be removed by a sharp-edged knife or chisel, and it was our observation that this condition probably tended to increase the corrosion troubles.

It was clearly evident to us, as it was to you, that some other type economizer would have to be designed if leakage trouble was to be eliminated. Inasmuch as we were of the opinion that one of the weaknesses of the original design was the rolled joint at the header, we directed our studies to produce an economizer that would have a minimum number of these joints.

The Re-Designed Economizer

The accompanying sketches, Figs. 1 and 2, show the final design that was developed and installed. The new economizer consists of five, continuous-tube elements, which are rolled into the square headers as indicated. Four of the elements are identical and therefore interchangeable. A ¼-in. by 3½-in. by 2-ft-4½ in. flat bar, provided with a slotted hole at the midpoint, is welded to each element, at the end opposite the square headers. The bar is bolted to continuous vertical angles on the economizer casing, in such a manner as to furnish a support for the element, and to provide for movement resulting from expansion. Flat steel spacers were welded to the tubes at the header ends, to maintain proper alignment of the elements.

We were interested to note that during our design we also considered a type of construction essentially similar to yours; however, as stated previously, our desire to eliminate as many joints as possible, caused us to decide in favor of the design shown.

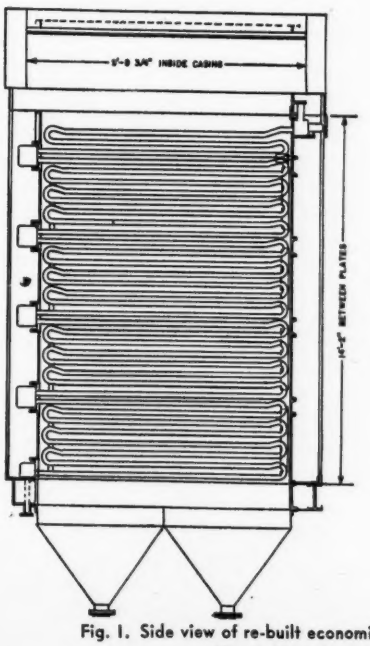
The boilers these economizers serve are fired by multiple-retort, underfeed stokers, and our studies of available data and information regarding economizer corrosion indicate that such difficulty is greatest with underfeed stokers — materially less with spreader and chain grate stokers—almost nil with pulverized coal—and often quite serious with oil firing.

Commenting further on a letter from Mr. Cotter, which we do not have, Mr. Derby added the following data:

We were interested in the comments of your letter with regard to our design. As to the lack of provision for cleaning the re-designed economizer, the water conditions at the particular plant involved are such that there has been little difficulty from scale forming in the interior of the economizer tubes.

We are sorry that our first letter did not clearly indicate the manner in which the economizer elements were supported. We are therefore en-

(Continued on page 61)



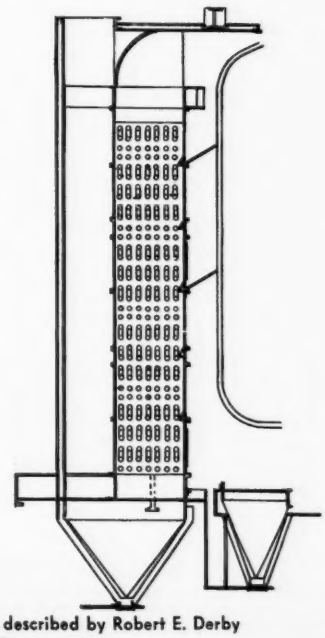


Fig. 1. Side view of re-built economizer as described by Robert E. Derby
Fig. 2. End view of re-built economizer

Jones & Laughlin's New 1,000,000-lb-per-hr Steam Plant

Five new steam generating units do the work of 43 older boilers . . . At South Side Works of Jones & Laughlin Steel Corp., Pittsburgh, Pa. . . . Give higher efficiency, occupy less space, help abate smoke . . . Entire plant constructed in 400 days, first boiler on line in 10 months . . . Burns low-grade "middlings" from corporation's mine washery, fired by spreader stokers . . . Dust collectors . . . Complete automatic combustion control and instrumentation

By **HARRY W. VANCE** Project Manager, The Rust Engineering Co.

WITH THE firing of the fifth boiler recently, a new steam generating plant, capable of producing well over 1,000,000 lb of steam per hr, was put in complete operation for Jones & Laughlin Steel Corporation's South Side Works at Pittsburgh, Pa. The plant has a rated continuous capacity of 875,000 lb of steam per hour at 150 psi, 466 FTT.

Designed and constructed by The Rust Engineering Co. of Pittsburgh, the new plant offers a notable example of the progress in steam generation during the past half century. With five units it replaces a total of 43 older boilers which have served the South Side of the Works for many years. The new boilers give a great increase in efficiency. They occupy less space, operate with greater economy, and will help further Pittsburgh's smoke control program.

The Plant Building

Construction of the entire plant, Fig. 1, from the breaking of ground to the firing of the final boiler, was completed in the elapsed time of 400 days, with the actual construction time running ahead of schedule. It consists of a steel frame building 220 ft long by 76 ft deep by 110 ft high. To support its weight, 213 steel piles, averaging 75 ft in length, were driven to bed rock. Walls are concrete for the first 10 ft above grade to a point 8 ft above the operating floor, and corrugated asbestos siding for the remainder.

The concrete wall section was designed to withstand flood water of the adjacent Monongahela River. All door frames are equipped to take flood-proof bulkheads.

Close cooperation, between Jones & Laughlin, The Babcock & Wilcox Co. and Rust as engineer-constructor, made possible the speedy building record.

Actual Construction

Work began on January 15, 1948 with the goal of getting the new steam generators into operation as quickly as possible. The first boiler was fired within 10 months; and the others, respectively, from that time, were fired within 8 days, 8 weeks, 10 weeks and 13 weeks.

Coal is brought in on cars running along the river side of the building and dumped into a track hopper. Car shakers housed over the hopper facilitate dumping.

From the hopper an automatically controlled skip hoist carries the fuel upwards 150 ft to the top of the building. Each of the two skip cars has a three-ton capacity; a complete cycle is made in 60 sec. Coal from the hoist is received in a hopper which feeds a belt conveyor. Coal from the belt conveyor is distributed to the bunker with a shuttle conveyor. The suspension type bunker extends the length of the boiler battery, and has a 3,000-ton capacity.

The coal to be used will be low-grade "middlings" from the Corporation's mine washery. This fuel normally will have 20 per cent ash and 12 per cent moisture content; and, since it represents a low-grade, high-ash, high-moisture by-product coal from the coal benefication system at the mines, its use as fuel for this boiler plant represents a substantial economy. The boilers and stokers are designed, however, to burn most grades of bituminous.

To reduce regular grades of bituminous to furnace size, a coal

Fig. 1. General view of new steam plant, Jones & Laughlin's South Side Works. Coal unloading facilities serviced by skip hoist. Ash temporarily stored in square silo is unloaded to railroad cars with dustless unloaders of pug mill type

Fig. 2. Looking down firing aisle of five boilers in new 1,000,000-lb-per-hr Jones & Laughlin steam plant

crusher is installed on a floor above the bunker. The crusher handles coal up to eight inch size, reducing it to size ¾ in. and down. Boilers are provided with auxiliary burners for coke oven gas, sometimes available from the Corporation's coking operations.

Water Treatment

Feedwater is drawn from the nearby Monongahela River and treated for boiler use in a separate cold process treating plant. The treated water is brought to a temperature of 220 F in a deaerating type heater. Four turbine driven pumps located on the ground floor pump feed water into the boiler drums. Additional treatment consisting of phosphate, fed directly to the drums, is provided. Maximum boiler water concentration of 3500 ppm will be maintained.

Steam Generators

The boilers are Stirling four-drum, bent-tube type with complete water-cooled boiler and furnace walls. Total heating surface is 21,155 sq ft per boiler. Water columns on each side of the boiler are provided with a high and low water alarm, and water level gage glasses are easily visible by a series of mirrors from the main operating floor. A three-element feedwater regulator controls water flow in relation to steam flow.

The boilers are equipped with air-puff soot blowers using air for blowing and for control. A master controller automatically governs the sequence of operation.

Spreader Stokers

The boilers are fired with spreader stokers which, due to the furnace width, are divided into two separate units driven independently on each side. A cinder return system is provided as part of the stoker installation, which returns all cinder and ash from the boiler soot hoppers, air heater, and from the dust collector to the combustion chamber.

To augment plant power and provide an additional source of energy for stoker and cinder-return motors, a 200-kw, 25-cycle, turbine generator set has been provided. During normal operation the turbine generator supplies the current for the auxiliaries. A plant power tie-in is provided for use during inspection shutdown periods.

In compliance with requirements of the recently enacted smoke law in Pittsburgh, dust collectors of the mechanical type were installed. As a check on automatic regulation and to facilitate readjustment to obtain proper combustion and the elimination of smoke, each unit is supplied with recorders, which measure and record the relative density of exhaust gas. Additional means to obtain compliance with smoke law regulations is provided by connections from the dust collectors to the pneumatic ash handling system. Connection for disposal of particles from dust collector hoppers, in lieu of reinjection, increases the means to obtain full compliance with regulations.

The ash handling system is of the pneumatic type using steam at 150 psig to provide the vacuum. Ash is stored temporarily in a concrete silo adjacent to the boiler plant. The ash is conditioned with dustless unloaders of the pug mill type and conveyed to the disposal area in railroad cars.

Combustion Control

A complete system of air-operated automatic combustion control is provided. This system allows for full automatic control of boilers individually or collectively, or provides

Views of Various Auxiliaries in South Side Works, 1,000,000-lb-per-hr Steam plant

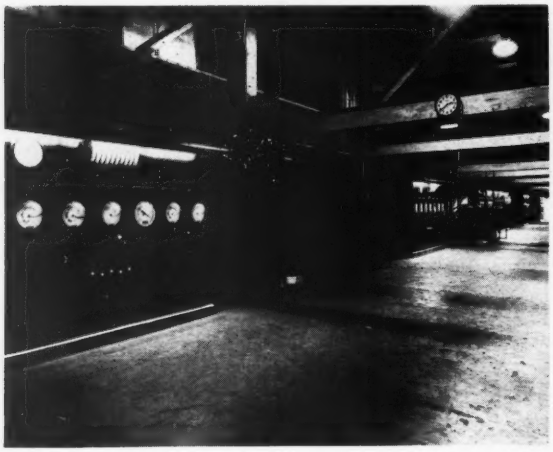


Fig. 3. Looking down line of five boiler control panels on operating floor, each equipped with smoke density recorder. Boiler No. 3 panel (from left) flanked by master control and distribution panels

Fig. 4. View of master controller, mounted on side of boiler, that automatically governs operational sequence of air-puff soot blowers. At right is disconnect switch for auxiliary forced-draft fan motor

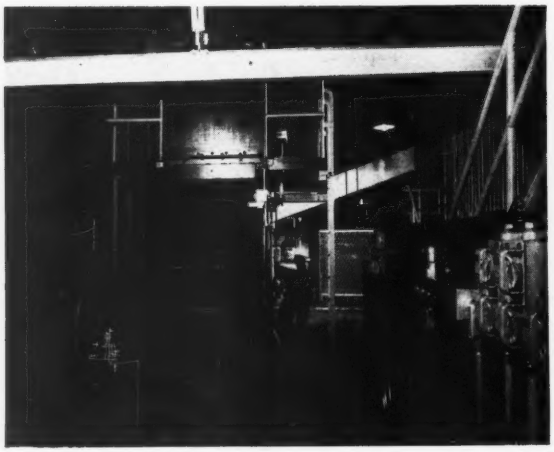


Fig. 5. Coal crusher installation on floor above suspension-type coal bunker. Crusher handles bituminous coal up to 8 in., reducing to ¾ in. and lower. Right background—skip-hoist winding machine

Fig. 6. Feeder conveyor (top), below coal crusher floor, dumps coal on track-mounted shuttle conveyor belt for distribution to suspension type coal bunker: Crusher shown in Fig. 5

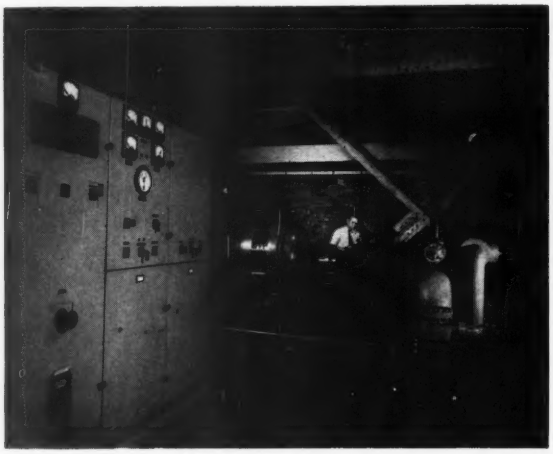


Fig. 7. This 200-kw turbine-generator set normally provides power for stoker and cinder-return motors. Auxiliary switch provides power from mill supply when generator is shut down

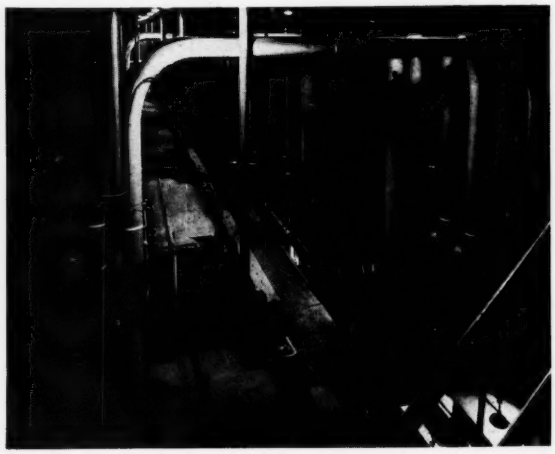


Fig. 8. View at boiler drum floor level, showing, at left, tops of boilers, boiler leads; at center, stub stacks; at right, main steam header, valves and piping supports

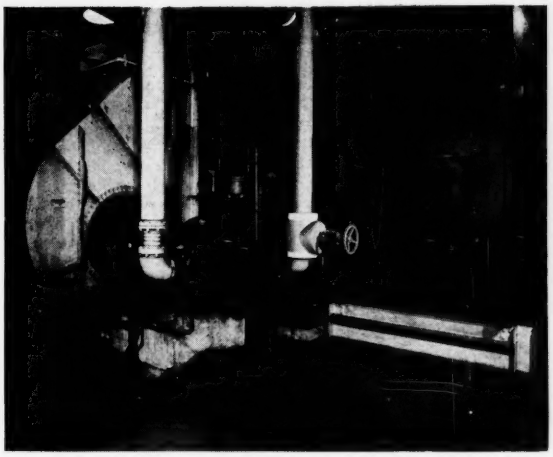


Fig. 9. Forced draft fan and dust collector, right, for one of five boilers. Each fan is driven by a steam turbine. Note piping, traps, control valves and accessories

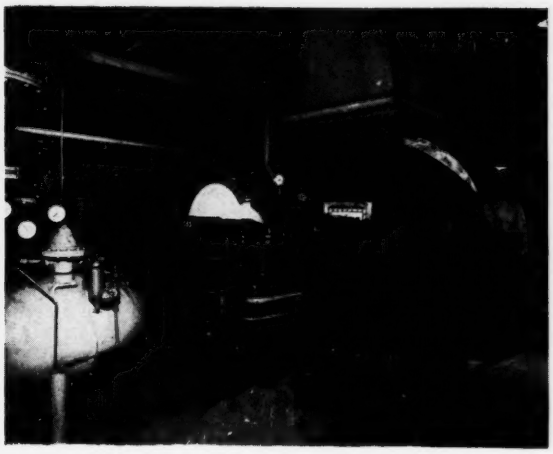


Fig. 10. Induced draft fan and drive for one of five boilers. Each fan is driven by a steam turbine. Note piping control valves and accessories

for running some of the boilers on manual control and some on automatic. The system is capable of controlling combustion when boilers are fired with either coal or coke oven gas, or a combination of these fuels. A motor driven compressor provides air for the combustion control. Air from the plant system is also available for operation of the combustion control equipment.

Instruments

Boiler Panels:—Each boiler is provided with a well-arranged panel on which are mounted draft gages, steam pressure gage, meters to record and integrate the flow of steam and feedwater, steam temperature, boiler drum water level, boiler drum pressure, record airflow, and temperature at various points, and record forced draft and furnace draft in inches of water. Boiler panels are also equipped with recording meters to indicate relative smoke density. Also mounted on the individual boiler panels are the relays and selector switches of the combustion control equipment and push buttons operating the motor driven boiler auxiliaries.

Master Panel:—A master panel is provided with gages to indicate steam header and feedwater header pressures; flow meter and pressure recorder for coke oven gas line; meters to record main steam header pressure, temperature and feedwater header pressure; and to record and integrate the flow of steam in the main header. Mounted on the master panel are meters to record water level and temperatures of feed water in the heater; to record and measure conductivity of steam, boiler water and measure the pH of treated water.

Also mounted on the master panel is a meter for recording percent of oxygen in flue gases; pressure controller to maintain constant differential between feed water header and steam header pressure; a pressure controller and selector valve to permit automatic or manual control of reducing station and boiler feed pumps. A distribution panel is provided with meters to separately record and integrate the flow of steam to boiler auxiliaries and to the four main steam distribution lines to the plant.

Additional Facilities

The building is equipped with combined personnel and freight elevator. Two offices for foremen are located off the main operating floor and above these, a foreman's locker

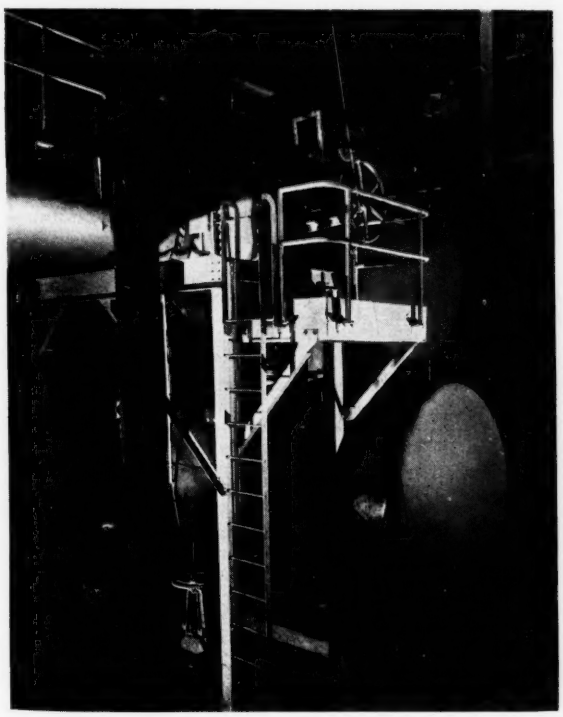


Fig. 11. (Left) Deaerating feedwater raises treated water temperature to 220 F

Fig. 12. These four turbine-driven pumps supply feedwater to boiler drums

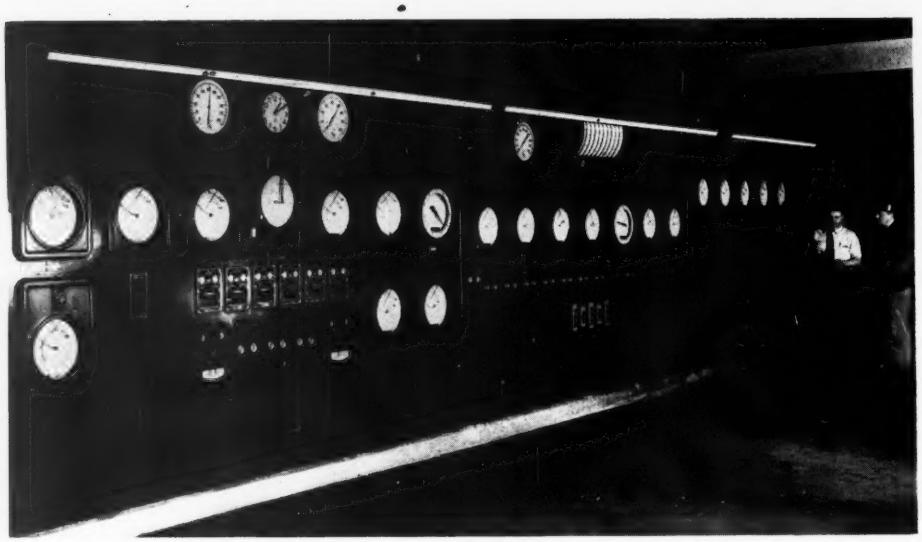


Fig. 13. Close-up of master control panel. Boiler panel No. 3 and distribution panel referred to in Fig. 3. R. H. Wilson (left), general boiler foreman, and W. D. Drummond, assistant boiler foreman, check distribution panel meters that separately record steam flow to boiler auxiliaries and main plant steam distribution lines

and toilet rooms. Washrooms, toilets, lockers and showers are provided for the men on the ground floor.

Electrical motor controls are all located in a brick-walled room on the ground floor to provide centralized access and adjustment. Room is made dust free by maintaining constant pressure of outside air.

Sub-Contractors

Main sub-contractors for The Rust Engineering Company during construction were: Pittsburgh Piping & Equipment Co., piping fabricators; The Philip Carey Mfg. Co., insulation; The Howard P. Foley Co., electrical installations; Stinson-Kennedy Co., plumbing heating and ventilating; Elwin G. Smith, corrugated asbestos work; Pittsburgh Plate Glass Co., glass and glazing; E. P. Dandridge Co., coal handling system; Otis Elevator Co., elevator; Arthur Painting Co., painting. Main equipment suppliers are shown in the accompanying list.

Principal Equipment, South Side Works' New Steam Plant

Boilers	The Babcock & Wilcox Co.
Stokers	Detroit Stoker Co.
Soot Blowers and BiColor Gage	Diamond Power Specialty Co.
Dust Collectors	Aerotec Corp.
Induced Draft Fans	American Blower Co.
I. D. Fan Turbines	Elliott Co.
Forced Draft Fans	Westinghouse Electric Corp.
F. D. Fan Turbines	Westinghouse Electric Corp.
Boiler Brick Work	The Rust Engineering Co.
Boiler Feed Pumps	Ingersoll-Rand Co.
B. F. Pump Turbines	Terry Steam Turbine Co.
Feedwater Heater	Elliott Co.
Turbine generator for Boiler Auxiliaries	Terry Steam Turbine Co. & General Electric Co.
Motors	Reliance Electric & Engineering Co.
Motor Controls	General Electric Co.
Instruments and Meters	Bailey Meter Co.
Combustion Control	Hagan Corp.
Car Shakeouts	Hewitt-Robins, Inc.
Ash Handling System	United Conveyor Corp.
Phosphate Feeding Equipment	Proportioneers, Inc.
Control for Skip Hoist	Electric Controller & Mfg. Co.
Soot-Blower Compressors	Worthington Pump & Machine Corp.
Draft Gages	Hayes Corp.
Blow-off Equipment	Liquid Conditioning Corp.
Auxiliary Feedwater Regulators	Northern Equipment Co.

COMBUSTION ENGINEERING—SUPERHEATER HELPS EXPORT TECHNICAL "KNOW-HOW"

A DEFINITE STEP in the direction of exporting American technical "know-how" along the lines proposed by President Truman in Point Four of his inaugural address and recently presented to Congress has been taken by Combustion Engineering-Superheater, Inc., New York, in a program of cooperation with one of Italy's largest industrial companies, Franco Tosi, S.p.A. of Legnano. The technical assistance rendered by Combustion, a leading American manufacturer of steam generating equipment, will enable the Franco Tosi Company to meet more adequately the Italian need for such equipment. It will also further the purposes of the Marshall Plan, in that certain sub-contracting work for steam generating units, previously purchased from Combustion under the Economic Cooperation Administration, will be carried on in Italy. This work will provide immediate employment, thus helping to absorb Italy's labor surplus and combating the efforts of communistic elements to regain the ground lost in last year's elections.

In addition to making available the American company's designs, the program provides for the communication of technical and manufacturing information, such as drawings, test data, and material specifications. Thus, the Italian firm would have available the same type of information that is used in conducting American manufacturing operations. Provision is also made to undertake special development work for Franco Tosi, including the furnishing of technical experts to work abroad.

Interchange of technical information will be facilitated by Franco Tosi's assignment of resident representatives to Combustion plants in the United States, their function being to study directly the methods of manufacture that are employed here. Reciprocally, American engineers may visit and study the operations of Franco Tosi in Italy, and that information may, in turn, be utilized in this country. The Franco Tosi organization operates large shipyards at Taranto and is Italy's leading producer of diesel engines. It also manufactures steam boilers.

This program exemplifies the opportunities for lifting world living standards through cooperative effort by privately owned companies. It is also a demonstration of the practical application of American "know-how" to the problem of economic recovery in other countries.

What the Hydroelectric Operator Needs to Know

About Hydraulic Turbine Governors

A short description of the principles of operation and construction of modern hydraulic turbine governors . . . Effect of flyball weight . . . Features of the regulating valve . . . Relay mechanisms . . . The synchronizer mechanism

By B. R. NICHOLS
Hydraulic Department, Allis-Chalmers Mfg. Co.

THE MODERN HYDROELECTRIC PLANT, despite its often great size, is a simple affair compared to the modern steam plant. Consisting simply of a hydraulic turbine rigidly connected to an a-c generator there is little to get out of order. From a mechanical standpoint, the most important thing is the governor and for this reason the operator in a hydroelectric plant must be thoroughly conversant with the design, construction and operating principles of the governor.

Many articles have been written on hydraulic turbine governors some of which are very comprehensive and involve exact mathematical analysis of governor operation. The average operator, however, is mainly interested in knowing something about the mechanical construction and operating principles of various governors and it is the purpose of this article to present this information simply and concisely.

Hydraulic governing equipment may be separated into two basic groups:

HYDRAULIC TURBINE GOVERNOR OPERATIONS

1. The oil pressure system from which the governor receives the energy to move the turbine gates, and

2. The actuator which controls the position of the turbine gates in relation to the turbine speed.

The principal elements of the governor mechanism are illustrated in the diagramatic sketch, Figure 1. The regulating cylinders may be mounted adjacent to the governor, or a pair of cylinders may be mounted in the turbine pit. The speed responsive element converts generator speed changes into linear motion. The floating levers transmits the flyball motion to the regulating valve which ports oil to the regulating cylinder in a direction causing the turbine gates to correct the flow of water into the turbine so an energy balance is maintained. The relay mechanism, including the dashpot and speed droop mechanism, is used to restore the regulating valve to mid-position, stopping the turbine guide vane movement at the proper opening to avoid over or under regulation. The synchronizer (speed level) mechanism is designed to shift a point in the relay mechanism to change the speed or load on the unit.

A conventional type of flyball arrangement is shown in Figure 2. Modern governor flyballs are generally driven by an electric motor in synchronism with the generating unit which the governor controls.

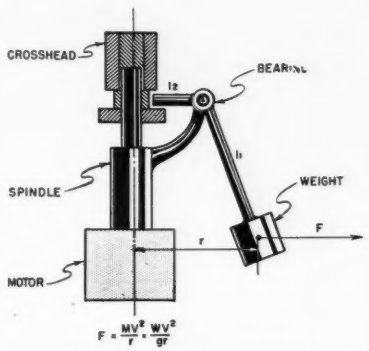


Fig. 2. Conventional type flyball arrangement

The cross head A, Figure 1 is the

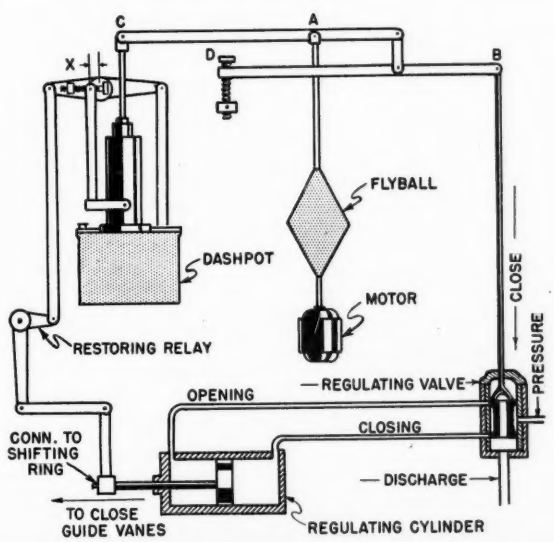


Fig. 1. Principle elements of the governor mechanism

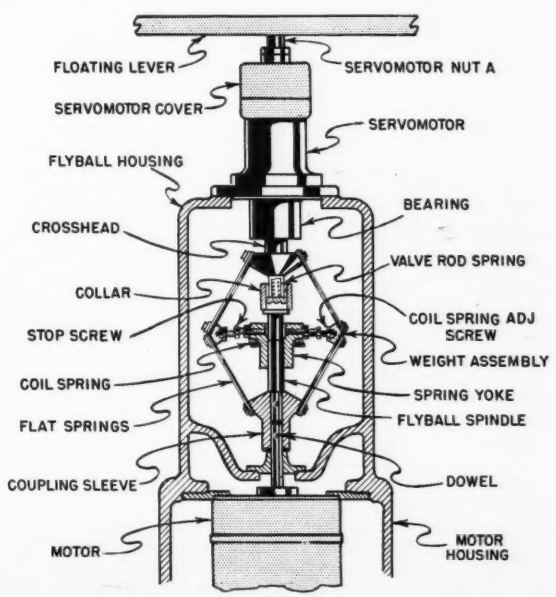


Fig. 3. Modern flyball arrangement

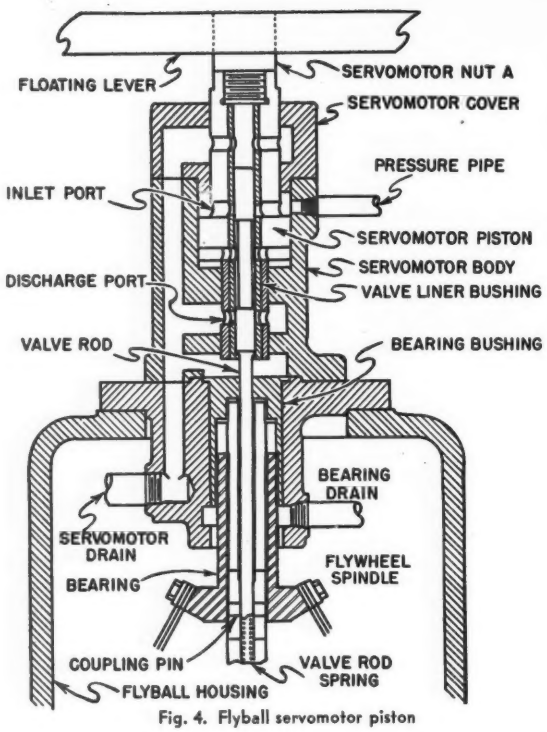


Fig. 4. Flyball servomotor piston

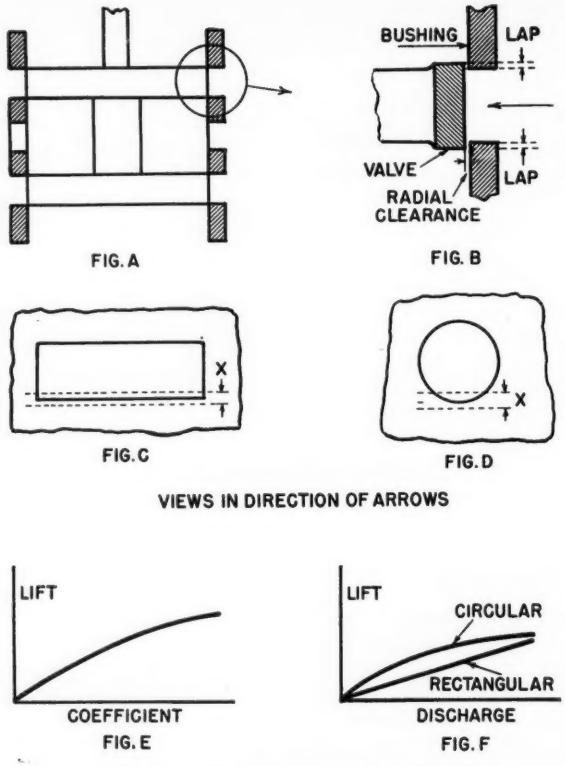


Fig 5. Details of regulating valve and operating characteristics

connecting link between angular and linear motion of the system. A simple example will show the care which must be taken in designing the flyball. To obtain the centrifugal force produced by flyballs rotating at 600 rpm using 1 lb weight rotating at a radius of 2-in. and lever ratios of l_1 = 2-in. l_2 = 1-in. as shown in Figure 2. Substituting this data in the formula $F = MV^2 \div R$ and correcting for lever ratios, the force at the cross head is found to be 81.52 lb.

If the speed of the machine is increased 0.01 of one per cent or 0.06 rpm the new force at the cross head will be 81.68 lb. The difference in force at the cross head then is 0.16 lb. or 2.56 oz. If the two springs between the flyball weights is designed for 20 lb. per in. of deflection the flyball weights will move outward $0.16 \div 20 \times 2 = 0.004$-in. and the cross head movement will be one-half of this value or 0.002-in. for 0.01 of one per cent speed change.

This example shows that forces produced by minor speed changes of the flyball are relatively small and that consequently every effort must be made to minimize the amount of friction in the flyball and connecting linkages to the regulating valve if accurate performance of the governor is to be expected.

The design of a flyball which overcomes these difficulties is illustrated in Figure 3 and 4. Motion and forces of the weight are transmitted to the cross head through flat springs thus eliminating pin joints. The cross head is connected to the servomotor pilot valve rod which positions the servomotor piston in accordance with the position of the flyball cross head. The friction between the pilot rod and servomotor piston is reduced to a minimum due to the relatively high linear velocity of the pilot rod.

The flyball servomotor piston, Figure 4, is operated by oil pressure, thus greatly multiplying the flyball force on the floating levers.

The regulating valve, Figure 5, is of the conventional piston type and controls the flow of oil to and from the regulating cylinders. It is generally operated by a small pilot controlled servomotor. Close fit of these parts are essential (Note Figure 5B).

Radial clearance must not be too small or metal-to-metal contact will cause non-uniform friction. If the valve fits too snugly in the bushing the viscosity of the oil film between these two members will cause a drag on the valve.

Increasing the radial clearance has the same effect on sensitivity of the valve as reducing the lap, but also increases the leakage. The optimum clearance and lap is dependent to a considerable extent upon the requirements of the system to which the generator is connected.

The shape of the valve ports also influence the governor performance as indicated in Figure 5. When considering the amount of leakage through the regulating valve, the required governor performance is of primary consideration and the frequency of governor oil pump operating is of secondary importance.

In the simplified diagram of governor floating levers shown in Figure 6, 1_1 and 2_2 are equal. The levers forming a bell crank which is connected to the regulating cylinder and rotates about point 0 are equal.

If we assume the turbine speed is increased so point A is shifted 0.1-in. to point A1, point B and regulating valve piston will be lowered 0.2-in. which will open the valve port by this amount minus the lap.

The turbine gates will be moved toward the closed position. The turbine gate motion will be stopped by rotating floating levers about A and recentering the regulating valve.

The amount of movement of the regulating cylinder in this case is 0.2-in. due to the ratio of the relay and floating levers. If point D had been set to coincide with O it is evident that the turbine gate motion would have continued to the end of the stroke.

The above description shows that the purpose of the floating levers is to transmit the flyball motion to the regulating valve then re-center the regulating valve by the turbine gate movement.

It is evident that for each position of the flyball cross head there is a definite position of the turbine gate. These positions may be shifted relative to each other, by changing the ratios of the restoring mechanisms or by changing the flyball characteristics.

The dashpot may be considered as a device for momentarily accelerating the relay movement. Figure 6

shows one end of the relay mechanism attached to the turbine gates, the other end to the right hand end of the relay lever, pivoted to the governor column Figure 7. The large dashpot piston is mechanically connected to the relay lever and hydraulically connected to the smaller dashpot piston. The latter piston is connected to the floating lever at C, Figure 1 and Figure 6.

The adjustable bypass valve provides an orifice between the upper and lower oil chamber in the dashpot. The automatic pressure operated valves are designed to limit the stroke of the small piston.

It is essential that the regulating valve be quickly returned to midposition after a speed change to prevent either an excess or deficiency of energy change to the turbine if close speed regulation is to be obtained.

A relay mechanism as shown in Figure 6 causes a large motion of point C to restore the regulating valve to midposition with a resultant wide change of turbine speed. (Point A will move to A′).

The dashpot corrects this defect by causing a relative large motion of point C (motion of C will be in the ratio or dashpot piston areas minus the leakage by the bypass valves). When the gate motion has stopped the small dashpot piston will be forced back to midposition by the centering spring at a rate determined by the setting of the bypass needle valve.

The rate of return of the small piston should be about the same as the rate of deceleration of the unit. A little study of Figure 6 will show that the addition of the dashpot has corrected defect and at the same time added another defect in the system in that point C will always return to the same point. This will cause the turbine gate to drift to either end of their stroke unless the speed or point A would always return to the same point which it will not do in practice. This defect in the mechanism is corrected by the addition of the speed droop mechanism, that is, making point 0 Figure 6 adjustable as shown in Figure 7. The amount of droop or stabilizing

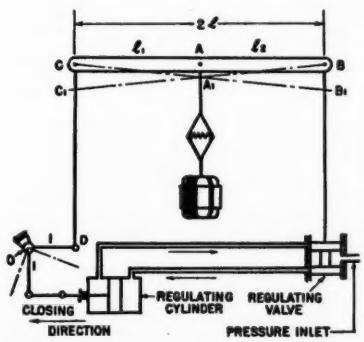
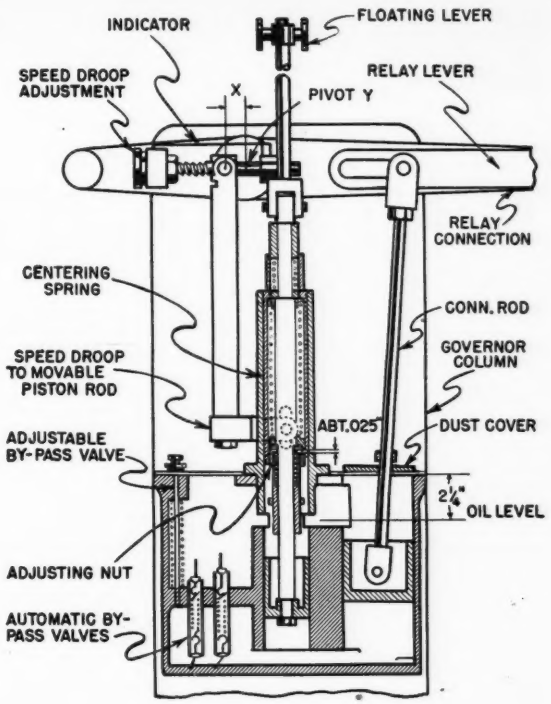


Fig. 6. Simplified diagram of governor floating levers

Fig. 7. Section through governor column



effect is determined by shifting 0 by an amount "X" Figure 7.

The synchronizer mechanism is a device whose function is to shift some point in the governor mechanism causing a change in gate position such as D, Figure 1.

If the generating unit is disconnected from a large system and D is shifted to increase the gate opening the unit will speed up and the flyballs will operate, attempting to restore the units speed back to the original speed. The difference in speed will be determined by the speed droop setting.

If the unit is connected to a large system, the speed of the generating unit will be the same as the system speed which will be only slightly affected by the change of gate opening on the unit in question; consequently the position of point A will remain nearly constant and the magnitude of the change in gate position will be in proportion to change in position of point D, Figure 1 and the speed droop setting "X", Figure 1.

LETTERS TO THE EDITORS

(Continued from page 53)

closing herewith a print which shows a detail of the flat bar which supports the element at the end opposite the headers. The elements are only supported at each end. The "three rows of large dots equally spaced in the tube bank," Fig. 1, referred to in your letter, are not supports, but are indications of the nozzle openings on the three vertical soot blower elements.

The plastic refractory (baffle mix) shown on Fig. 1, to be applied on the headers at the point where the elements are rolled in, is installed in order to protect the rolled joints from any excessive heat from the gases.

We were particularly interested in your statement that you are of the opinion that the type of firing equipment would not have much effect on the redesigned economizers, and in addition we were surprised to note that the temperature of the water entering your economizers is only 185 F. As indicated in our original letter, our own studies have shown that the firing equipment does have some effect on the economizer corrosion problem, and that this effect is even more pronounced when the entering feed water temperature is less than 230 F.

Philadelphia, Pa. R. E. DERBY

* * *

An electret is a permanently electrically polarized material (usually a dielectric) that exhibits an electrical field near its surface. It has now been demonstrated that assemblies of electrets can exert a pull on a ferrous material like a magnet. More amazing is the fact that batteries can be made of electret assemblies, using an electrolytic paste to convert static charges into current electricity.

DESIGN

What Are Fan Guarantees Worth?

Why fan manufacturers cannot, in good faith, INDISCRIMINATELY guarantee INSTALLED PERFORMANCE . . . The well-known Fan Doctor presents a vigorous, thoroughly-documented rebuttal of accusations often made against power plant fans and their manufacturers . . . What forced and induced draft fans are and are not designed to do . . . Factors entirely outside the fan that affect its performance and operation . . . How the user can employ the fan manufacturer's experience in eliminating fan difficulties before installation . . . Why the technical committees on fans write the Standard Test Codes as they do . . . Typical example of how changes in fan and duct details influence fan performance, making it very close to "specified" conditions

By JACK CASSIE,
Research Engineer, Sturtevant Division, Westinghouse Electric Corp.

WHATEVER the topic of discussion may be, technical or otherwise, in the majority of cases argument between parties disappears when the question is specifically set down in black and white and its meaning understood and agreed upon by both parties.

In connection with the sale and purchase of a steam generating unit, the question of guarantees naturally arises. The generator manufacturer makes specific guarantees of performance under specific conditions of operation. The motor manufacturer does likewise. The boiler people specify their terms of guarantee very specifically as to fuel, maximum number of hours per year the boiler is to be run at specific overload, and so on and so on.

Induced-Draft Fan Complaints

Another element of a steam generating unit is the induced-draft fan. Some of the most frequently recurring complaints against it fall into the following categories:

1. Corrosion
2. Erosion
3. Noise
4. Vibration
5. Pulsation
6. Aerodynamic performance

As will be seen, in the majority of cases, the complaints are unjustified criticisms against the fan manufacturer.

In connection with *corrosion,* fans made of standard material are often purchased for applications where special consideration should be given due to the handling of corrosive or high temperature atmospheres. It may be necessary to handle the problem by use of a primary (clean-air) fan jet, which induces flow of the troublesome medium without the latter's passing through a fan. Where temperature will permit, fan parts that come into contact with the medium can be rubber-coated. In cases of high temperatures, special metals can be used.

The fan manufacturer can often be of valuable service in suggesting ways and means of extending wheel life against corrosion, basing suggestions upon similar past installations encountered.

Air Heaters and Pulverizer Exhausters

When the temperature within an air heater drops below the dew-point, the air heater parts are in danger from corrosion. The customer wards off its occurrence by means of artificially raising the

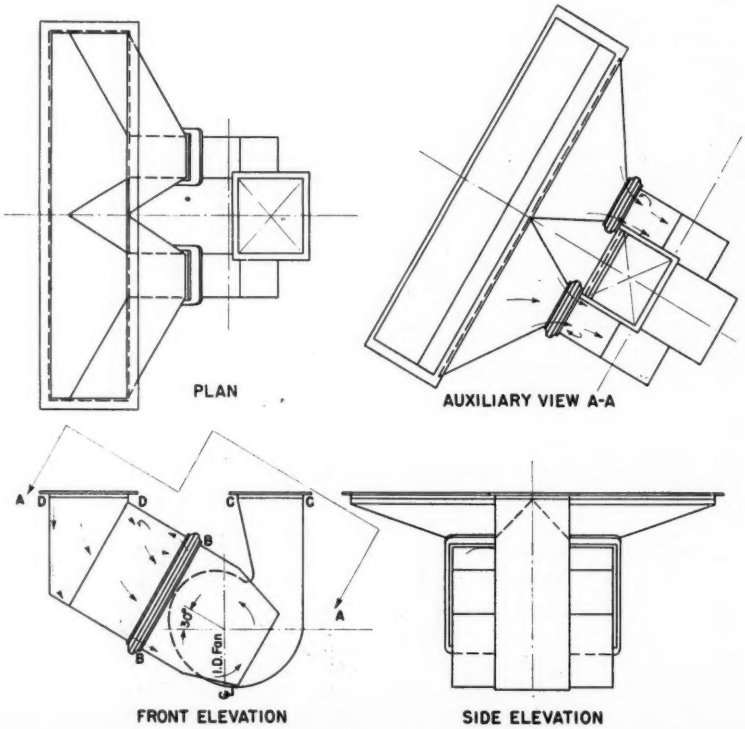


Fig. 1. Plans and elevations of a proposed fan design

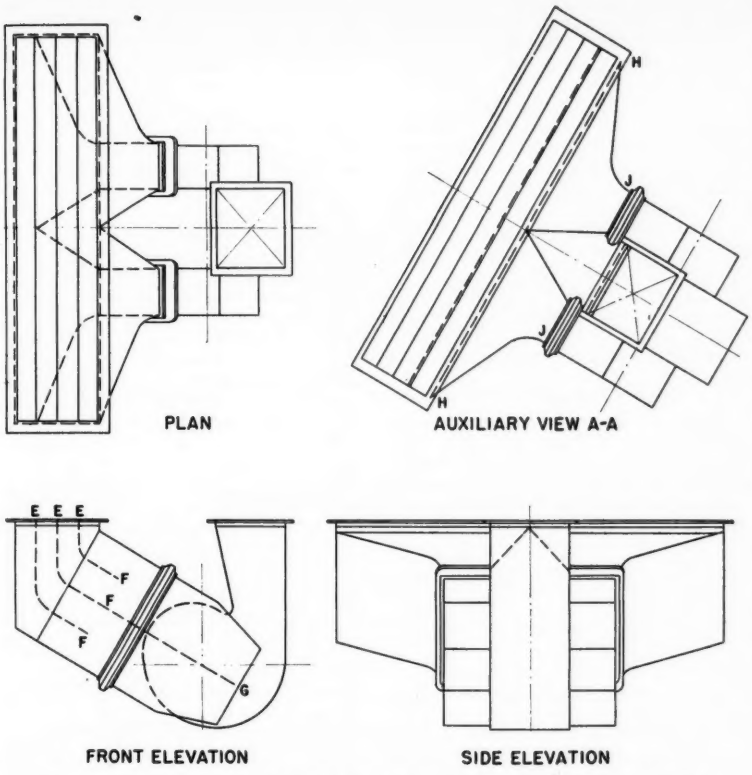


Fig. 2. Plans and elevations of fan design of Fig. 1, modified by discharge vanes E-F

temperature to a proper point. No complaint is registered against the air heater manufacturer because of corrosion.

In the case of a pulverizer exhauster, the customer reasons logically that, since this fan is to handle a dust-laden medium, there will definitely be consequent *erosion* of fan parts. This leads to the selection of a fan unit as appropriate as the state of the art affords. The casing is built with substantial thickness—usually with replaceable wearing plates covering the interior surfaces at strategic locations determined by past experience. The wheel is usually of the "good old workhorse" paddle type. This design decreases the tendency for conveyed material to accumulate on the blades during operation and the consequent mechanical unbalancing, causing outage of the fan for servicing. Worn blades, being of simple flat plate design, are readily and quickly replaced in the user's own shop. The repaired wheel is rebalanced and placed in service. The maintenance is expected, foreseen and planned for.

What the I.D. Fan Is Up Against

The induced-draft fan is also required to handle not only flue gases but also a portion of the material that already has eroded the pulverizer exhauster which handled it. Offhand one would think that the owner of both the pulverizer exhauster and the induced-draft fan would be consistent enough to expect erosion of the induced-draft fan and provide for its maintenance. However, so many induced-draft fan users held the fan manufacturers responsible for the wear caused by (the users') fly-ash and looked for free fan parts replacement, that fan manufacturers had the choice of "going in the red" or handling the situation in a fair, logical manner.

Since there are an infinite number of combinations of erosion factors (such as type, grade and screen analysis of coal and ash, ash concentration as it passes across the wheel blades and through the casing, the velocity of the ash relative to the surfaces it contacts, etc.) it would be impossible to make, in good faith, specific guarantees of wheel life. The reliable fan manufacturer is anxious to cooperate with the customer and give him the benefit of experiences gained on other installations. The manufacturer can assist only in *minimizing* the erosion caused under a given set of operating conditions. It is the writer's opinion that the influence of wheel tip speed as one of the causes of erosion has been over-emphasized. (One case history, at *constant tip speed,* proved this contention. See *Power Plant Engineering,* March, 1947; "Small Duct Change Triples Fan Life, Raises Steam Output 24%).

A very recent study of wheel blades and blade liners, under identical operating conditions, has led to specification of definite materials and definite techniques in applying these materials to prolong fan life.

However, not as a manufacturer's alibi, but as an economically logical necessity, the following statement from the National Association of Fan Manufacturers Bulletin No. 105 should be studied.

Abrasion:—To study the effect of abrasion, the Association for several years past has been investigating and experimenting with plate alloys, coatings and forms of construction. To date no materials or means have been discovered which will effectively and completely resist such abrasive action. Some materials are better than others. The resistance to abrasion, then, is one of degree only.

"Experience having shown on the basis of present day knowledge of the art that erosion, corrosion or results of excessive heat are speculative assumptions of maintenance, it is the policy of the Association to advise buyers of the fan equipment that guarantees covering such conditions cannot be made in good faith."

The fan manufacturers' proposals reiterate this statement of policy to avoid possible future argument.

What Causes Noise?

Again, after applying a fan on an installation the purchaser may consider the overall job as being excessively *noisy.* What is considered as a noisy air conditioning or heating and ventilating job in an office or store might not be considered objectionable in a power plant, where the noise level is fairly high at best. Where mechanical draft fans have to produce pressures to 80-in. water gage and higher, considerable noise is expected. If noise reduction is essential, the use of sound absorbing materials is necessary.

There are other cases, however, where fans develop lower pressures, in which the noise level of the overall draft system causes complaints. The same fan, placed on other systems, would draw no comment from a noise standpoint. In fact, on several noise complaint jobs, bleeding air through an artificial orifice, between the fan and its attached duct system, to atmosphere, has proved conclusively that the noise was not due to the fan itself but rather to a combination of surrounding conditions of duct-work, and the like, which were suitable to give a musical instrument effect. If the cause of the noise cannot be eliminated, the noise must be absorbed.

It may be a fact that "when the fan is not running there is no noise," as often set forth by fan users. However, this is no reason for blaming the fan for the noise.

While fan manufacturers are interested in the fan users' problems (See *Power Plant Engineering,* August 1947 p. 84 "Mouth Organ Engineering.") it must be remembered

that their staffs are composed of *fan* engineers, *not acoustical* engineers. Any but the simplest of noise problems should properly be assigned to a reputable sound engineering firm to solve.

Where Does Vibration Come From?

Regarding any moving equipment parts, vibrations of various sorts may occur. When purchasing, say an induced draft fan, the buyer has the right to expect a properly-balanced fan wheel and collars, bearings, and other parts that will not cause excessive vibrations when properly installed on proper foundations. There are times, even with such a unit, when the structures surrounding, or in any manner physically attached to the fan, may vibrate. Even the well-balanced fan may thus be caused to shake. The fact is noted that the vibration occurs only when the fan is running. The conclusion often put forth is that, therefore, the fan is responsible for the excessive vibration.

However, a fan is sold to produce air horsepower output. This output is partly in the form of kinetic energy and partly in the form of potential energy. Were it a pump delivering a smooth stream of water, it would not surprise the user if this stream, impinging upon a nearby plywood wall, vibrated or fractured the wall in its path. It is no more surprising when a smooth stream from a fan wheel hits a nearby partially-closed damper, or other steel sheet, placed at an angle to the stream.

In the case of either pump or fan, if the stream is handled in a proper manner according to fluid flow laws, no undue vibrations would be set up. The pump should not be blamed for the plywood wall vibrating; the fan should not be blamed for the partially-closed damper leaves or other sheets vibrating.

Carrying the example of the fan plus partially-closed damper a step further, suppose the damper leaves to be made much stiffer and prevented from oscillating on their shafts. The energy of the stream is still present. The stream becomes turbulent in passing through and leaving the damper. The vibration from the turbulence will, by transmission along the rigid leaves, be carried to the support of the leaves.

Vibrations and pulsations due to details of the connected system should not be blamed upon the fan. A good example of high horsepower output from a fan without serious vibration of the connected system is seen at any high-velocity wind tunnel where fluid flow principles are closely followed.

The above-mentioned problems are rare when compared with the aerodynamic performance complaints which are often made.

Performance Complaints

Consider a recent actual case where such a complaint arose. The fan as it was to be shipped is shown in Fig. 1 at B-B to C-C. Luckily the fan manufacturer had the opportunity to inspect the detailed layout of the ductwork which the customer proposed using to connect from air heater outlet D-D fan inlet boxes at B-B.

The fan manufacturer pointed out that, with this connection in place, the fan performance obtained in the field would be considerably below the laboratory performance because of the difference between the Code set-up duct connection and the ductwork he proposed. This statement was made on the basis of actual laboratory investigation results, which will be described below.

Means for improving this connection by means of streamlining sheets shown in Fig. 2 at EF, FG and HJ were suggested. The customer then asked—"Will we obtain *full* performance if we incorporate these suggestions?"

The answer was, "No."

The next question should properly have been—"How far will the performance be off if we incorporate the suggested improvements as indicated in Fig. 2?" The answer would then have been, "The matter of a few percent and well within the safety factors usually applied by customers in specifying fan requirements."

One further question was asked by the customer, "Under what conditions *will* you guarantee full catalog rating?"

When the answer was made that full performance is guaranteed only when the installed fan ductwork duplicates that which was used in determining catalog rating—namely, according to the Standard Test Code —this customer, like many others, said, "That may be OK for you fan people to get together and set up rules, which give you an alibi and allow you to shirk your responsibilities when, for instance, we are unable to obtain the expected maximum steam output when using your fan bought according to a specified volume and pressure requirement; but that is an unfair practice from the user's standpoint."

In the first place, the customer expects steam output. However, a fan does not generate steam. It is a device for moving quantities of gas (or air) against the resistance of the system through which it is required to flow. This it will do according to certain definite physical laws.

Study of a Typical Case

To study the fairness or unfairness of the manufacturer's and customer's contentions, let us trace the history of the fan shown in Fig. 1.

The Fan Designer, with the most up-to-date fluid flow and empirical data on hand, designs the fan shown BB to CC of Fig. 1. In order to place performance data on a fixed basis, common to the other manufacturers in the same industry, a joint committee of the American Society of Heating and Ventilating Engineers and the National Association of Fan Manufacturers, with cooperation from Committee No. 10 of the Power Test Code Committee of the American Society of Mechanical Engineers worked together toward this end. This work resulted in the first edition of the Standard Test Code for Centrifugal and Axial Fans which was issued in 1923.

The second edition, adding data on testing centrifugal fans with inlet boxes, was issued in 1932.

The present, third, edition was issued in 1938 under the direction of the same authorities as the first and second editions.

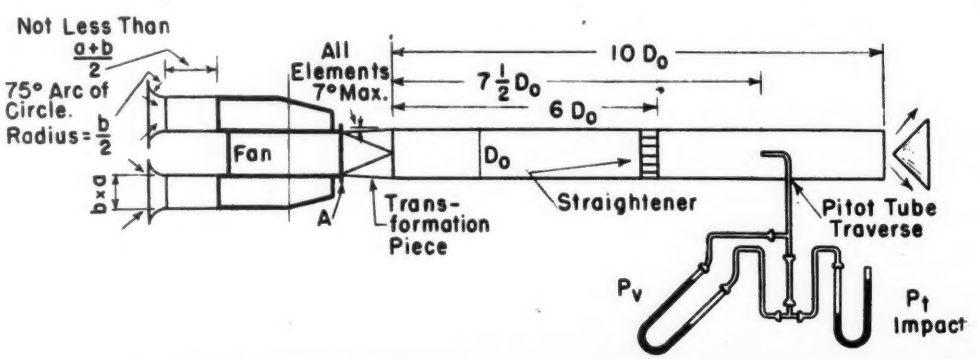


Fig. 3. Test set-up for blower with inlet boxes as published in the Standard Test Code for Centrifugal and Axial Fans, NAFM

The Code is published in Bulletin No. 103 of the National Association of Fan Manufacturers. It is also printed in engineering handbooks. Thus it would seem that it is widely enough publicized as to be easily accessible to users of fans.

Figure 3, which is Plate III of the Code, shows the test set-up of a blower equipped with inlet boxes. As noted also in the Code, paragraph 38, "All determinations for fan performance are to be based on *unobstructed inlet* and outlet except for the structural features of the fan involved."

Effects of Inlet and Outlet Changes

The above covers very specifically how the fan of Fig. 1 is to be tested; any "obstruction," such as the inlet connection DD-BB of Fig. 1, or even the improved version of it as shown in Fig. 2 will result in a performance different from Code performance.

Variations in fan output due to variation of frictional resistance of the physical system attached thereto is usually well understood and realized; the type of fan output and efficiency change caused by an obstruction such as DD-BB of Fig. 1 is not as fully realized.

To illustrate this type of output variation, consider Fig. 4. Dash line curve L represents the unobstructed inlet Code test "static pressure" over the full range from no delivery to free delivery; L′ the corresponding "static efficiency."

When the flow is through a 90-deg turn before reaching the inlet boxes, the volume, pressure and efficiency values become those shown on Curves N and N′ (although the fan itself has not been changed.)

If now the diagonal of the 90-deg elbow inlet connection is fitted with properly designed corner turns, the greater part of the lost performance is restored, as shown in full line curves P and P′.

Suppose the specified duty (L) for which the fan is sold is 26,000 cfm at 5.25 in. static pressure and that other "system resistance" values lie on the locus LPN.

Wherever a fan is applied to a duct system the resulting performance will be where the *actual* "system characteristic" (or system resistance) crosses the *actual* fan characteristic.

Thus, with no elbow at the inlet box entrance we obtain (at intersection L) 26,000 cfm at 5.25 in. static presure and (at 26,000 cfm at L′) 62 per cent static efficiency.

However, when the unvaned elbow is placed upstream from the inlet box we obtain (at intersection N) 22,600 cfm at 3.97 in. static pressure and (at 22,600 cfm at N′) 39.5 per cent static efficiency.

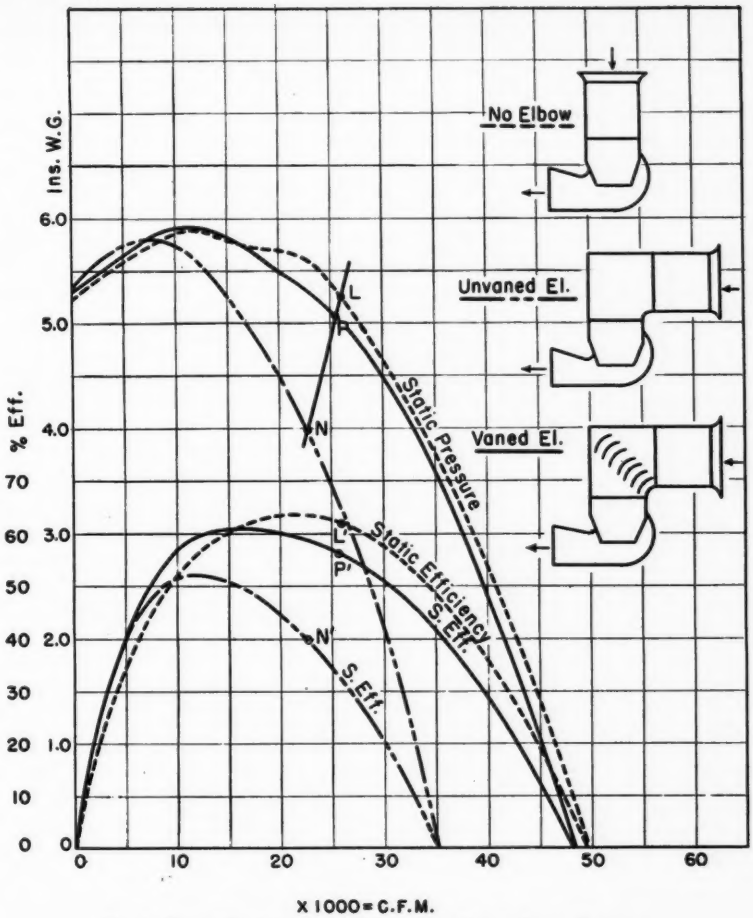


Fig. 4. Curves showing effect of inlet connection on fan performance

By vaning the diagonal of the elbow we can boost these values to (P) 25,600 cfm at 5.06 in. static pressure and (P′) 56 per cent. The following percentage table shows this comparison more clearly.

Comparing the proposed layout of Fig. 1 with the "unvaned elbow" set-up represented on Fig. 4, we see that the change of direction of the gas flow in each case is such as to produce a spin, within the inlet box, having the same rotation as does the fan wheel. This causes the stream to enter the wheel in such a manner that the *effective* blade angles of the wheel blade are changed. The result is, of course, a change in fan performance.

While the connection of Fig. 1 turns through less than 90 deg, it has another detrimental effect, which is easily seen in "Auxiliary View A-A" of Fig. 1, namely the end contractions caused at the junction of the inlet connection and the inlet box. This prevents the stream from utilizing the full area of the inlet box cross-section. The *effective* box size is thus smaller than the designer found necessary for full performance.

Referring to Fig. 2, vanes EF on the elbow diagonal prevent crowding of the stream and the tendency toward spinning. The central vane extension FG makes more definite the elimination of spin possibility.

Entrance flare at J ("Auxiliary View A-A," Fig. 2) duplicates those shown on Code set-up of Fig. 3.

With these corrective means (Fig. 2) incorporated we may expect to be as close to "Specified" conditions as P is to L on curve sheet, Fig. 4.

The comparative curves of Fig. 4 are not something new nor something the fan manufacturer has up his sleeve but are taken from a paper appearing in *Transactions A.S.M.E.* Sept. 15, 1933, Volume 55, No. 11, Fig. 19.

With such basic knowledge on hand it is readily realized why a fan

(Continued on page 92)

Table showing effects of inlet changes as in Fig. 4

	Percent Loss in cfm	Percent Loss in Pressure	Percent Loss in Static Efficiency
No elbow	0.0	0.0	0.0
Unvaned elbow	13.1	24.3	36.3
Vaned elbow	1.5	3.6	9.6

Several years ago[1] we published in these pages a series of articles describing a new method of delineating armature windings devised by William A. Taylor. These articles with the diagrams explained at length the various winding connections for all the different types of armature windings in use. In these diagrams, the whole magnetic field is rolled-out, as it were, to suit the number of magnetic pole zones, phase-belts, and coils. Laid out on fundamental principles the diagram is recommended to all power plant and industrial engineers who should make full use of it in obtaining a pictorial record of their generator and motor windings. This will be of great help in knowing what to do in case of sudden burn-outs. Now, in another and final article, Mr. Taylor shows how to use this diagram in connection with generally used windings of the complicated type. For simplicity they are presented in naked or skeleton form showing only the basic conditions such as magnetic poles, phases, coil throw, electrical angular degree relations, etc. Don't let the apparent complexity of these diagrams scare you. They are well worth your study; it is an education in itself to fill-in the coil to coil connections per phase winding and analyze the results. To the initiated they visualize everything desired

A New Armature Winding Diagram

By WILLIAM T. TAYLOR

ABOUT TEN YEARS ago two university educationalists presented a paper before the AIEE showing how the electrically identical coil-sides of unequally-grouped-coil dead-slot armature and wound-rotor windings could be identified and a correctly connected and properly balanced winding built-up mathematically.

When dealing with pressures, stresses, weights and equilibrium of forces, the graphical method has largely replaced the mathematical—this applies to concrete and other structures as well as electrical circuits and apparatus. In the case of concrete or masonry dams, almost the entire design is carried out graphically such as the section and its middle third limits, centre of gravity, centre of pressure, the desired position within the middle third where the resultant pressure crosses the base, etc. The graphic method is equally applicable to electrical problems such as the magnetic field and windings of dynamo electric machinery. Due to the fact that conventional armature winding diagrams are not real graphic representations they should be discarded because they not only show a backwardness in the art but they fail to picture the truth such as the magnetic pole zones, phase belts, true coil-throw and the electrical degree positions, phase leads, electrically identical and other positions for integral and fractional slot and/or coil, chorded, unequally grouped coil, and "dead" slot windings.

Some time ago these columns published[1] a series of articles showing graphic presentation explaining at length the various winding connections for lap, wave, concentric, mush and basket; single and multi pole-pair windings, as also integral, fractional, chorded and other windings. In each case a fully developed winding was shown graphically with every coil-side and phase belt and magnetic pole zone in its true electrical position. This article, with the exception of showing a fully developed 3-phase/2-phase (and *vice-versa*) winding, deals with naked or skeleton layouts that take the place of mathematics for finding the electrically identical phase-lead and other coil-side connections and positions of the most complicated windings. Printed in one corner of the Record Cards of generator and motor (used in armature winding departments, power stations and certain industries) this form of skeleton diagram can be most helpful and instructive; all that is necessary is to fill-in the coil and winding connections of old, new, or rewound, armatures and wound rotors thus showing the exact connections and conditions, what can and should be done, and what cannot be done with such windings and connections; with this information on record for every armature and wound rotor in power house or industry the operating engineer is not left in doubt as to what is or is not possible when further burn-outs occur. For details of different winding connections the reader should obtain from this journal photostat copies of the previous articles.[1]

Figure 1 shows the skeleton and superimposed arrangement of an 8-pole 6-phase, 72-slot and coil full-pitch layout and a 72-slot 60-coil (1¼ coils per pole per phase) full-pitch layout. If desired a 60-slot layout may be drawn on the left of this diagram which would check exactly the electrically identical coil-side positions and corresponding electrical degree angles. It is omitted here because the electrically identical coil-side positions and their electrical degree angles are already shown. Fig. 1 also shows a 6-phase and a 3-phase layout; we see how a 3-phase can be converted to a 6-phase, and *vice-versa*. This is instructive because we see all the electrical angular degree relations and posititons of phase leads, etc.; we see where there is phase-current overlap, for instance top coil-side 41 phase and 2 has the bottom coil-side in phase 5, and the top coil-side in slot 32 phase 4 has its bottom coil-side in phase 1. In this form of winding diagram the whole magnetic field is layed out flat to divide into pole zones, phase belts, and coil-throws of equal or various lengths such as is found in concentric windings.

Visualized results of Fig. 1 layout are given in Table I:

Table I

Phases	Electrically identical top coil-side positions									
1	1	16	2	17	8	23	9	24	10	25
2	41	56	42	57	48	3	49	4	50	5
3	6	21	7	22	13	28	14	29	15	30
4	31	46	32	47	38	53	39	54	40	55
5	11	26	12	27	18	33	19	34	20	35
6	36	51	37	52	43	58	44	59	45	60

A naked diagram in appearance, Fig. 1 visualizes the top and bottom electrically identical full-pitch and fractional-pitch positions, the phase-lead positions, and the electrical degree angle of every coil-side in the winding. The fully developed winding layout is shown in Table II, which the reader may fill-in for practice.

[1] *Power Plant Engineering* of April, June, July, August and November of 1943, and June of 1945.

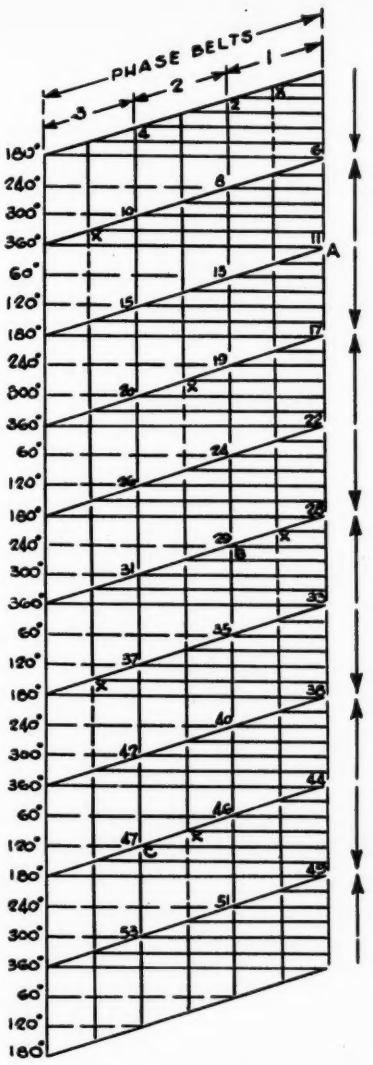


Fig. 1. Skeleton and superimposed arrangements of an 8-pole, 6-phase, 72-slot and coil full-pitch layout and a 72-slot 60 coil full-pitch layout

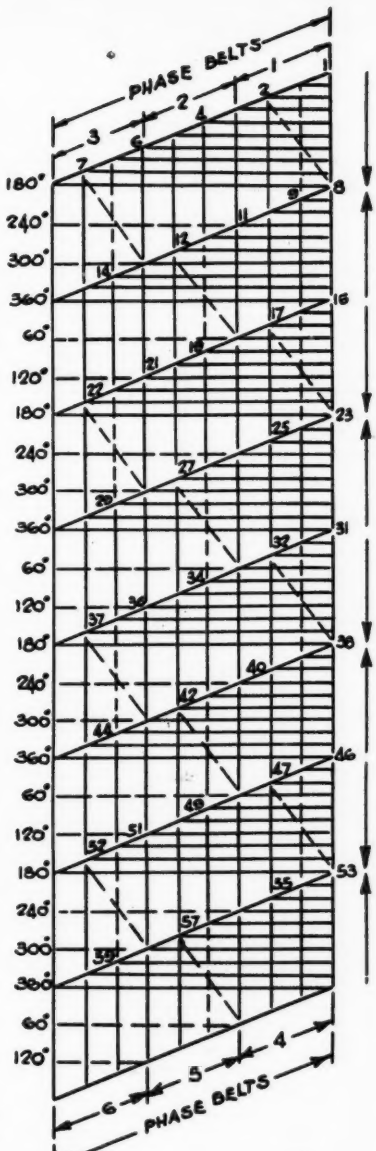


Fig. 2. Skeleton diagram of superimposed arrangement of a 10-pole, 3-phase, 60-slot and coil full-pitch layout and a 10-pole, 3-phase, 60-slot 50-coil full-pitch layout

Tabulating according to the positions of the electrically identical coil-sides per phase winding, we get Table III:

As the number of poles and phases and slots are increased so the size of a diagram should be increased for clarity.

Figure 2 is a simple skeleton diagram showing the superimposed arrangement of a 10-pole 3-phase 60-slot and coil full-pitch layout, and a 10-pole 3-phase 60-slot 54-coil (1.8-coils per pole per phase) full-pitch layout. The "dead" slot intervals equal 10 and the coil grouping reads:

2 2 2 2 1 2 2 2 2 1 2 2 2 2 1
A B C A B C A B C A B C A B C
(repeat this again)

Table II

Phase	(T)	(B)	(T)	(B)	(B)	(T)	(B)	(T)	(B)	(T)	(T)	(B)	(T)	(B)	(B)	(T)	(B)	(T)	(B)	(T)
1	1	8	-2	10	-17	10	-x	9	-16	8	-16	23	-17	25	-32	25	-x	24	-31	23
2	41	48	-42	50	-57	50	-x	49	-56	48	-56	3	-57	5	-12	5	-x	4	-11	3
3	6	13	-7	15	-22	15	-x	14	-21	13	-21	28	-22	30	-37	30	-x	29	-36	28
4	31	38	-32	40	-47	40	-x	29	-46	38	-46	53	-47	55	-2	55	-x	54	-1	53
5	11	18	-12	20	-27	20	-x	19	-26	18	-26	33	-27	35	-42	35	-x	34	-41	33
6	36	43	-37	45	-52	45	-x	44	-51	43	-51	48	-52	60	-7	60	-x	59	-6	58

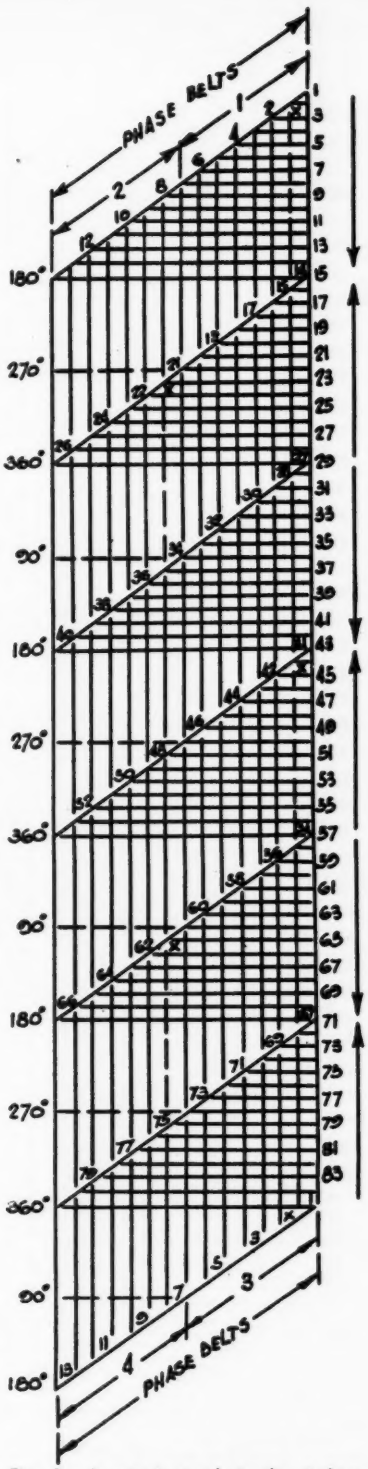


Fig. 3. A superimposed 6-pole, 4-phase, 84-slot skeleton layout and an 84-slot 80-coil full-pitch layout

It is customary to indicate the line starting end of phase 1 as slot 1, but Fig. 2 shows other equally satisfactory phase-lead positions such as slot 11 (360°) phase 1, 29 (240°) for phase 2, also 47 (120°) for phase 3; the other positions are 1 (0°) for phase 1, 19 (240°) for phase 2, and

37 (120°) for phase 3. We thus get a visual check on the possible number of phase-lead positions one can use.

The correct electrically identical coil-side positions are checked by their locations on the same vertical *phase-pitch* line (and over the same circle in a polar diagram) or/and by their corresponding electrical angular degree positions. Excluding the latter values, the fully developed winding table (extracted from Fig. 2) is shown in Table IV.

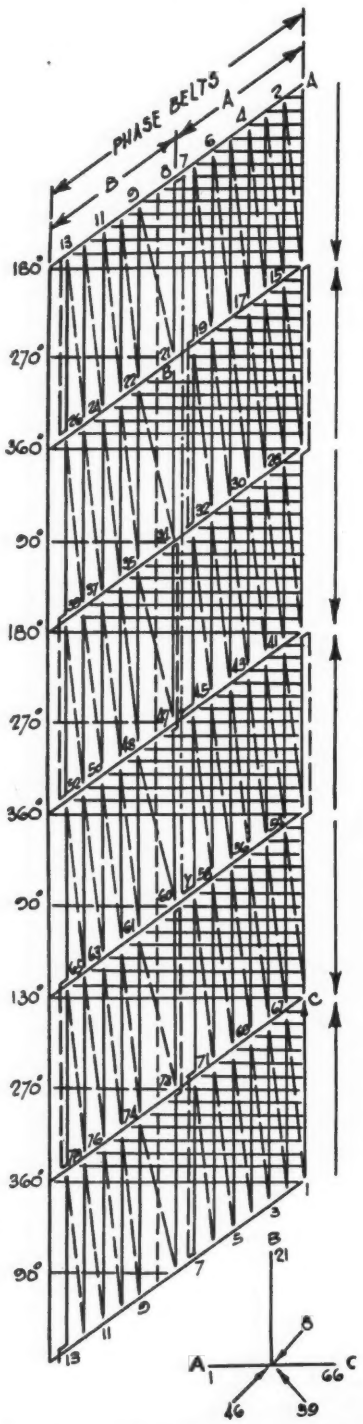


Fig. 4. An 84-slot, 6-pole, 2-phase layout

Table III

Phase		(T)	(B)	(T)	(B)	(B)	(T)	(B)	(T)	(B)	(T)		Phase Overlap Pole Zones
1	(0°)	1/16	8	-2	10	-17	10	-x	9	-16	8	(180°)	4 with 1
			23	-17	25	-32	25	-x	24	-31	23		1,2,3 and 4
2	(240°)	41/56	48	-42	50	-57	50	-x	49	-56	48	(60°)	5 with 2
			3	-57	5	-12	5	-x	4	-11	3		6,7,8 and 1
3	(120°)	6/21	13	-7	15	-22	15	-x	14	-21	13	(300°)	6 with 3
			28	-22	30	-37	30	-x	29	-36	28		1,2,3 and 4
4	(360°)	31/46	38	-32	40	-47	40	-x	39	-46	38	(180°)	1 with 4
			53	-47	55	-2	55	-x	54	-1	53		5,6,7 and 8
5	(240°)	11/26	18	-12	20	-27	20	-x	19	-26	18	(60°)	2 with 5
			33	-27	35	-42	36	-x	34	-41	33		2,3,4 and 5
6	(120°)	36/51	43	-37	45	-52	45	-x	44	-51	43	(300°)	3 with 6
			58	-52	60	-7	60	-x	59	-6	58		5,6,7 and 8

Table IV

Phase 1

(T)	(B)	(T)	(B)	(B)	(T)	(B)	(T)
11	17	-12	18	-23	18	-22	17
22	28	-23	x	(x)	-33		28
33	38	-34	39	-45	39	-44	38
44	49	-45	50	- x	50	- 1	49
1	6	- (x)	-11		7	-12	6

Phase 2

(T)	(B)	(T)	(B)	(B)	(T)	(B)	(T)
29	35	-30	36	-41	36	-40	35
40	46	-41	x	(x)	-51		46
51	2	-52	3	- 9	3	- 8	2
8	13	- 9	14	- x	14	-19	13
19	24	- (x)	-30		25	-29	24

Phase 3

	(T)	(B)	(T)	(B)	(B)	(T)	(B)	(T)	
Phase lead	47	53	-48	54	- 5	54	- 4	53	
	4	10	- 5	x	- (x)	-15		10	
	15	20	-16	21	-27	21	-26	20	
	26	31	-27	32	- x	32	-37	31	
	37	42	- (x)	-48		43	-48	42	Neutral lead

Starting in phase 1 slot 1 for Fig. 1, the electrically identical coil-side positions (down the same vertical line) are 1, 16, 31 and 46, all at the same 260° electrical degree angle; then 8, 23, 38 and 53, all at the same 180° positions. For Fig. 2, starting in phase 1 and slot 1, the electrically identical positions down the same vertical line are 1, 11, 22, 33 and 44, all holding the same 360° positions; then 6, 17, 28, 38 and 49 holding the same 180° electrically identical positions. The tabulated series arrangement given above shows that the vertical figures correspond to the same electrical degree angles. For Fig. 2 the phase-lead positions are top 11 for phase 1, top 29 for phase 2, and top 47 for phase 3. By connecting tops (T) 17 and 22, 28 and 33, 38 and 44, 49 and 1 of phase 1 (leaving tops 11 and 6 for phase and neutral leads), the whole phase winding becomes a single series connection. If two separate and similar circuits per phase winding (a 2-parallel winding) is required, the winding table for phase 1 would then read as shown in Table V.

The electrically identical top coil-sides are shown in Table VI.

Figure 3 displays a superimposed 6-pole 4-phase 84-slot skeleton layout, and an 84-slot 80-coil (3.333-coils per pole per phase) full pitch layout. Close examination shows why slot 1 is chosen as phase 1 line lead position, slot 21 phase 4 starting position, and slot 61 phase 2 starting position. Slot 2 is the first "dead" slot interval; the spacing of the four "dead" slots are 2, 22, 42 and 62, hence the interval is 21. A jumper goes from (B) 14 to (T) 2 in phase 1, (B) 34 to (T) 22 in phase 4, (B) 54 to 42 in phase 3, and (B) 74 to (T) 62 in phase 2; x is an actual coil-side, and for the lettering of the 84-slot layout it is (B) 2 in phase 1, (B) 23 in phase 4, (B) 44 in phase 3, and (B) 65 in phase 2. Naked as Fig. 3 appears to be to

Table V

Phase 1 as a 2-parallel winding

(T)	(B)	(T)	(B)		(T)	(B)	(T)	(B)
11	17	12	18		38	44	39	45
22	28	23	x		49	1	50	x
33	38	34	39		6	12	7	11
44	49	45	50		17	22	18	23
1	6	(x)			28	33	(x)	

Table VI

Phase	Electrically identical top coil-side positions									
1	11 / 6	23 / 17	33 / 28	44 / 38	1 / 49	12 / 7	23 / 18	34 / x	45 / 39	x / 50
2	29 / 24	40 / 35	51 / 42	8 / 2	19 / 13	30 / 25	41 / 34	52 / x	9 / 3	x / 14
3	47 / 42	4 / 53	15 / 10	26 / 20	37 / 31	48 / 43	5 / 54	16 / x	27 / 21	x / 52

Table VII

Phases	(T)	(B)	(T)	(B)	(T)	(B)	(T)	(B)	(T)	(B)	(T)	(B)	(T)	(B)	Pole Zones
	(0°)	1	14--	(x)	--	2	15--	3	17--	4	18--	5	19--	6	20	
1		33	46--32		45--31		44--30		43--29		42--28		x--27		41	1, 3 and 5
		54	67--55		68--56		69--57		70--58		71--59		72--60		73	(257.142°)
	(270°)	21	34--	(x)	--22		36--23		37--24		38--25		39--26		40	
4		53	66--52		65--51		64--50		63--49		62--48		x--47		61	2, 4 and 6
		74	7--75		8--76		9--77		10--78		11--79		12--80		13	(167.142°)
	(180°)	41	54--	(x)	--42		56--43		57--44		58--45		59--46		60	
3		73	6--72		5--71		4--70		3--69		2--68		x--67		1	4, 6 and 2
		14	27--15		28--16		29--17		30--18		31--19		32--20		33	(77.142°)
	(90°)	61	74--	(x)	--62		76--63		77--64		78--65		79--66		80	
2		13	26--12		25--11		26--10		27-- 9		28-- 8		x-- 7		21	5, 1 and 3
		34	47--35		48--36		49--37		50--38		51--39		52--40		53	(347.142°)

Table VIII

Phases	Electrically identical top coil-side positions
1	1 27 54 x 28 55 2 29 56 3 30 57 4 31 58 5 32 59 6 33 60
4	21 47 74 x 48 75 22 49 76 23 50 77 24 51 78 25 52 79 26 53 80
3	41 67 14 x 68 15 42 69 16 43 70 17 44 71 18 45 72 19 46 73 20
2	61 7 34 x 8 35 62 9 36 63 10 37 64 11 38 65 12 39 66 13 40

Table IX

	(T)	(B)	(T)	(B)	(T)	(B)	(T)	(B)	(T)	(B)	(T)	(B)	(T)	(B)	
Phase A (0°)	1	14--	2	15--	3	16--	4	17--	5	18--	6	19--	7	20	
	14	27--15		28--16		29--17		30--18		31--19		32--20		33	
	27	40--28		41--29		42--30		42--31		44--32		45--33		46	
	40	33--41		54--42		55--43		56--44		57--45		58--46		59	
Phase C (180°)	53	66--54		67--55		68--56		69--57		70--58		71--59		72	
	66	1--67		2--68		3--69		4--70		5--71		6--72		7	
	(B)	(T)	(B)	(T)	(B)	(T)	(B)	(T)	(B)	(T)	(B)	(T)	(B)	(T)	
	26	13--25		12--24		11--23		10--22		9-- (x)		--21	8		y(90°)
	13	78--12		77--11		76--10		75-- 9		74-- (x)		-- 8	73		
	78	65--77		64--76		63--75		62--74		61-- (x)		--73	60		
	65	53--64		52--63		51--62		50--61		49-- (x)		--60	47		
	53	39--52		38--51		37--50		36--49		35-- (x)		--47	34		Phase B (270°)
	39	26--38		25--37		24--36		23--35		22-- (x)		--34	21		

the uninitiated, this skeleton diagram permits the extraction of a fully developed winding; thus, starting with phase 1 as the top coil-side in slot 1 we get the fully developed lap-connected winding tabulations shown in Table VII.

Phase 1 and 3 also 2 and 4 may, respectively, be connected in single series (each from top to bottom) to form a 2-phase winding such as shown in Fig. 4 which represents a 3-phase/2-phase reconnection. Thus, for phase 1 arrangement connect bottoms 20 and 33, tops 14 and 27, bottoms 46 and 60, tops 41 and 54, bottoms 73 and 5, leaving tops 71 and 1 for the two terminal phase leads. The electrically identical top coil-side positions shown in Table VIII.

The layout shown in Fig. 4 is basically an 84-slot 6-pole 2-phase. In this case two more slots are made "dead"† one per pole and all in the same phase because the 2-phase lap-connected winding is to be reconnected to give a 3-phase/2-phase "T" connection. Fig. 4 is a fully developed winding, illustrating an 84-slot 78-coil 6-pole 2-phase lap-connected layout (initially operated as a 2-phase winding with seven fully active slots per pole and phase) reconnected as a 3-phase "T" winding with 4.33 mean number of active coils per pole per phase. The active coil ratio of the "T" connected 3-phase winding being 1.0:0.866 or 42.0:36.37; the nearest practical coil ratio is 42 in phase AC and 36 in yB phase. A fully developed 2-phase 84-slot and coil full-pitch lap winding, and a fully developed 3-phase/2-phase 84-slot 78-active coil full-pitch lap-coil "T" connected winding can be extracted from Fig. 4.

The simplicity of this form of diagram for the more complicated windings such as this 3-phase/2-phase reconnection is clearly evident. Fig. 4 is basically an ordinary 2-phase layout with two series connected single-phase windings. Six "dead" slot intervals are seen to occur at equi-potential positions intersecting one complete (vertical) *phase-pitch* which is the equivalent of one complete circle in a corresponding polar diagram. The single series terminal lead-positions in this case are 1 and 66 for phase 1, with 8 and 21 for phase 2; the 3-phase winding phase-leads are 1, 21 and 66. The two phase-winding "T" connection requires the joining of coil ends 8, 46 and 59, which later is marked y.

The extracted 3-phase/2-phase winding is given in Table IX.

The above mentioned "dead" slot fractional coil per pole per phase windings can be classified as:

Fig. 1	Coil Layout	Phases	Poles	Class of Winding
1	1.25 coils/pole/phase	6	8	even coil, even phase, and even pole pair.
2	1.80 " " "	3	10	even coil, odd phase, and odd pole pair.
3	3.33 " " "	4	6	even coil, even phase, and odd pole pair.
4	4.33 " " "	2/3	6	even coil, even/odd phase, and odd pole pair.

† With the exception of Fig. 4 no slot is completely "dead," one active coil-ride is in each x slot position; in every case the x slots may have the full compliment of active coils with the "fractional" disconnected.

STUDY HYDRO POWER DEVELOPMENT IN NEW ENGLAND

By Richard LaCoste

Currently being considered by Congress are some seventy-five bills dealing with the promotion of hydroelectric power. All have their defenders and detractors. But HR 253, introduced by Rep. John Davis Lodge (R-Conn.), appears to have the backing of business-minded legislators.

Briefly, the bill calls for authorization of an appropriation of funds for a complete and comprehensive survey of the Merrimac and Connecticut rivers and other rivers in the New England States having power possibilities.

Several other similar bills have been introduced. Governor Chester Bowles, of OPA fame, supports the measure. Business is undecided.

In a statement for the record, Lodge said:

"The recently manifested trend of large industrial concerns to move away from New England to other sections of the country because of the high rates locally charged for power makes this study especially vital."

The joint engineer and power commission survey authorized in this bill is similar to that on which TVA was initiated in 1926.

Lodge pointed out that "citizens of New England are required to contribute millions of dollars for low-cost hydroelectric projects on the rivers of the South, West, and Northwest. It is only fair," he added, "that the people of New England share in the benefits.

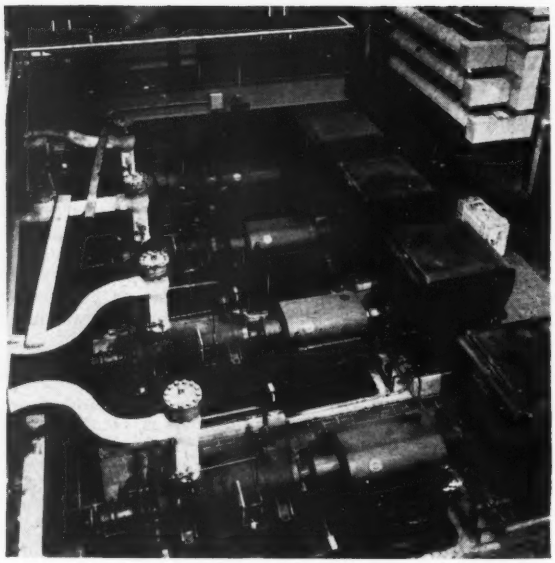


Fig. 1. Four of the six boiler feed pumps serving two boilers at Sewaren. Temperatures are recorded in each of bearings of hydraulic couplings, also in each of two main pump bearings on each unit and in two bearings on each driving motor

Fig. 2. Speedomax instrument at upper left records 160 temperatures in superheater tubes; associated switch unit selects tube temperatures in succession. Two eight-point instruments record conductance of condensate and boiler feedwater

Centralized Automatic Temperature Monitoring at Sewaren

AMONG THE MANY modern features* at the new Sewaren Generating Station of Public Service Electric and Gas Co. of New Jersey, is provision for automatic monitoring of important temperatures in the plant. Each of the two boiler-turbine units now in service is equipped with a pair of multiple-point high-speed recording instruments, one for bearing temperatures and the other for superheater tube temperatures. A third boiler-turbine unit scheduled to start operation this fall will have identical instrument equipment . . . making a total of six of these instruments in this station.

Like the other apparatus on the Sewaren control panels, the temperature recorders are intended to facilitate station operation by concentrating the control and supervision of all principal plant equipment at one central location.† From the operating point of view, this station design makes it possible for a small group of men to maintain constant watch over all phases of plant operation. With continuous instrument measurements available to warn against overheating, the operating force can head off trouble before costly failures and shutdowns occur.

The temperature recorders are Speedomax instruments, made by Leeds & Northrup Co. They can handle 160 separate temperatures; in other words, with four of these recorders, station operators can keep track of 640 temperature points in the plant equipment.

Bearing Temperatures

Bearing temperatures are recorded for each boiler-turbine unit in the critical spots shown in the table. These bearing temperatures are detected by copper-constantan thermocouples inserted either in the bearing metal or in the lubricating oil, and connected to the recorder by matched extension wires. The couple element is enclosed in a thin, flexible protecting tube from which it is thoroughly insulated to prevent errors due to stray currents. Designed for high-speed response, the couple keeps closely in step with bearing metal or oil temperature. Because the potentiometer method is used for measurement, the length of connecting wire between couple and re-

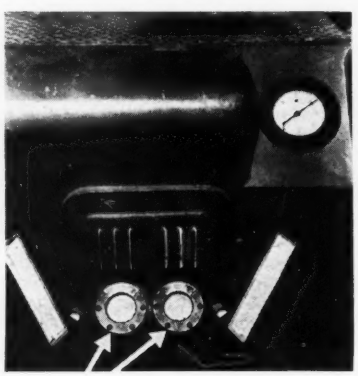


Fig. 3. Thermocouples are installed in look box for detecting temperatures of oil in main turbine bearing

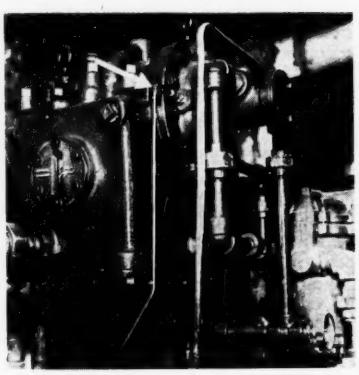


Fig. 4. Location of thermocouple lead for boiler feed pump outboard bearing on units shown in Fig. 1

*Sewaren—Milepost of Progress; POWER GENERATION, July 1949, Pages 66-73 presented; general description of important features.

†See POWER GENERATION, July 1949; front cover illustration Fig. 8, page 71, Fig. 9, page 72.

Table showing bearing temperatures recorded on each boiler-turbine unit at Sewaren

Turbine generator:	Thrust bearing 8 other bearings
Exciter	5 bearings
Pulverizer mills (3 for each boiler)	2 Pinion gear bearings 2 Exhauster motor bearings 2 Mill motor bearings 2 Mill bearings
Boiler Feed Pump Equipment (3 for each boiler)	2 Pump motor bearings 4 Bearings in fluid coupling 2 Pump bearings
Regenerative Air Heaters (2 for each boiler)	2 Guide bearings 2 Pinion gear bearings 2 Reduction gear bearings
Forced Draft Fans (2 for each boiler)	2 Fan bearings 2 Motor bearings 2 Fluid coupling oil temperatu es
Induced Draft Fans (2 for each boiler)	2 Fan bearings 2 Motor bearings 2 Fluid coupling points
Condensate Pumps (2 for each turbine)	2 Motor bearings 2 Pump bearings
Vacuum Pumps (2 for each turbine)	2 Motor bearings 2 Pump bearings
Circulating Pumps (2 for each turbine)	2 Motor bearings 2 Pump bearings
Fuel Oil Pumps (total of 3)	2 Motor bearings 2 Pump bearings
Motor Stator temperatures	2 Circulating pumps 2 Condensate pumps Generator exciter 3 Boiler feed pumps 3 Pulverizer mills 3 Pulverizer exhausters 2 Forced draft fans 2 Induced draft fans

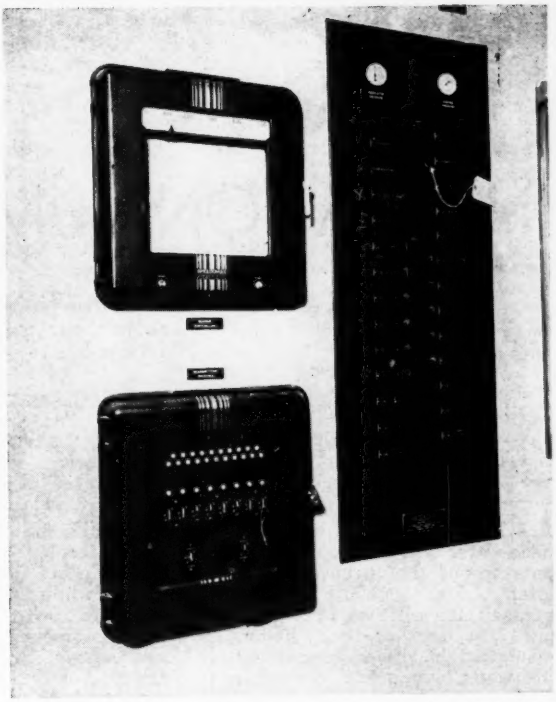


Fig. 5. One of the two 160-point Speedomax recorders for bearing temperature measurements at Sewaren. At top: Speedomax recorder; below: associated multi-bank switch unit. As each temperature is indicated or recorded, numbered lights on switch unit flash on to identify points in succession

corder has no effect on accuracy of measurement.

Superheater Tube Temperatures

In addition to the bearing temperature instrument, each boiler is equipped with a similar recorder for superheater tube temperatures. Information supplied by this instrument is useful as a guide for setting soot-blowing schedules, and as a permanent record, which is used for studying details of superheater performance.

Superheaters are divided into primary and secondary sections, the latter operating at higher temperature. In the primary section, consisting of 95 tubes, temperatures are measured in 14 tubes at regularly spaced intervals. Every one of the 124 tubes in the secondary superheater is recorded.

Tube temperatures are detected by chromel-alumel thermocouples, which are permanently mounted in the individual tubes in such a way as to detect actual temperature of the metal.

Instrument Details

Each recording equipment consists of two parts: a Speedomax recorder, which does the actual indicating and recording, and a multibank switch unit, which automatically connects the various thermocouples in succession. Thermocouples are wired to the switch unit in eight banks of twenty each. As each couple is measured, numbered lights on the switch unit identify it by bank and sequence number in the bank. Operating in synchronism with the switch unit, the recorder prints a series of 21 numbered dots for each bank; twenty temperatures plus one dot, printed in the left margin of the chart, to identify the bank which is being recorded.

Recording speed is four seconds per point. At this rate, the Speedomax covers all 160 temperatures in 10.7 minutes.

The bearing temperature recorders have a range of 0 to 500 F, while those for superheater tubes cover 0 to 1200 F.

Several different types of operation are available. The instrument can be left indicating only, monitoring all points in rotation without recording or moving its chart. If any temperature gets too high, the instrument automatically starts recording, and at the same time operates an alarm to notify plant personnel. Whenever the operator wants the Speedomax to record, he simply throws a switch and the instrument keeps on recording until a second switch is thrown. For convenience in shooting trouble, or in making detailed observations, the operator can concentrate the measurements on any desired group of points, or even on a single temperature.

Similar temperature recording equipment for a single boiler-turbine unit has been in operation for nearly two years at Essex Station.

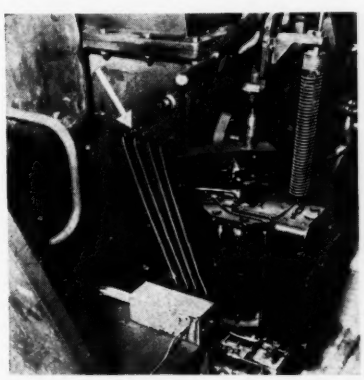


Fig. 6. Closeup of feed pump hydraulic coupling, showing thermocouple leads entering housing of coupling. Couples are run to a junction box, connecting wires feed in conduit to Speedomax recorder

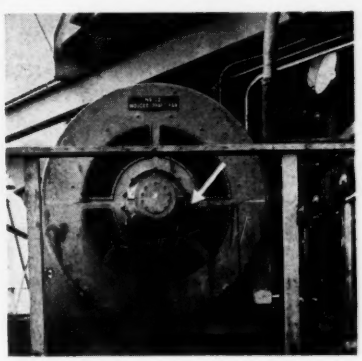


Fig. 7. Location of thermocouple in outboard bearing on induced draft fan. (Semi-outdoor boilers, hence fans and other draft equipment are out-of-doors; see *Power Generation*, July 1949.)

INSULATION of Modern Waterwalls

Heat transmission through refractory walls . . . Need for waterwalls in connection with pulverized coal . . . Heat loss from boiler casings . . . Fuel savings by use of insulation . . . Prevention of air leakage . . . Construction of modern furnace walls . . . Completely cooled walls

By W. D. STEVENS, The Babcock & Wilcox Company

IN THE DAYS when all boilers had solid brick settings with no furnace water cooling, the outside temperature of the furnace walls was often as high as 350 F. This made a repairman's life an uncomfortable one. On most of these boilers, if insulation had been placed outside the walls to improve working conditions and decrease heat loss, the temperature of the brick would have gone up enough to make the furnace walls fail in a short time. Therefore, the only practical way of approaching comfortable conditions was by good boiler room ventilation, and in some instances by the use of air-cooled furnace walls.

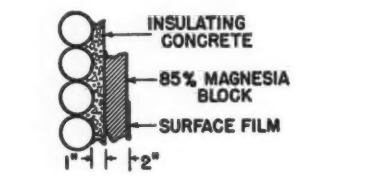
The use of pulverized coal, higher duty furnaces, and larger boiler units resulted in the development of various kinds of water-cooled walls. Two types of waterwall—the "tube and brick" and the "completely cooled"—are now used on the majority of high-duty boiler units, while uncooled refractory walls are used only for low duty.

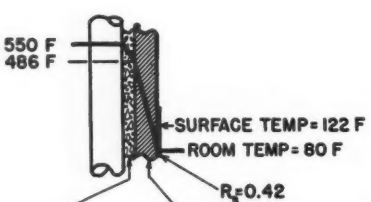
The *completely cooled* type is made of tangent tubes (like those in Fig. 7), or tubes a short distance apart with the space between them closed by extended surface welded to the tubes. This type of wall presents to the furnace a surface which is at or near the temperature of the steam and water within the tubes. It is used wherever slagging conditions can be expected.

The second type, (Fig. 6) known as a "tube and brick" wall, is made up of tubes with 1 in. to 7 in. open space between them backed up with about 2½ in. of firebrick or tile. In many cases the refractory backing is supported directly from the tubes. The cooling effect of the tubes prevents deterioration of the refractory, but the exposed brick is somewhat vulnerable to slag adhesion, so this wall design is not used where severe slagging is likely.

Either "completely cooled" or "tube and brick" walls can be covered with any desired thickness of insulation without materially changing the inside temperature It has become general practice to make the insulation thick enough to assure comfortable working conditions while trying to keep a reasonable balance between the cost of fuel saved by insulating the boiler and the cost of the insulation. The heat economy and comfort requirements, of course, can be satisfied with practically any arrangement and type of insulation if it is the correct thickness and the material will stand the temperature to which it is exposed. However, it has been found that insulation can also be used as an effective seal against air infiltration into the boiler. Therefore, the possibility of using the insulation in this manner must also be considered in the economics of the design.

In order to maintain reasonably good working conditions around a boiler, the insulation must be thick enough to reduce the heat loss from the walls to a quantity which can be removed by the air circulating in the room without an appreciable increase in the air temperature. In addition, the insulation must keep the outside surface of the wall reasonably cool.





$$R = \frac{L_1}{K_1} = \frac{1}{1.55} = 0.64 \qquad R_2 = \frac{L_2}{K_2} = \frac{2}{0.55} = 3.64$$

$$R = R_1 + R_2 + R_3 = 0.64 + 3.64 + 0.42 = 4.70$$

$$Q = \frac{T_1 - T_2}{R} = \frac{550 - 80}{4.70} = 100$$

Fig. 1. Heat flow in a closely spaced tube wall

Symbols: Q = Heat flow, Btu/sq ft x hr
R = Resistance, Sq ft x hr x Deg F/Btu
K = Conductivity, Btu x in/sq ft per hr per Deg F.
L = Thickness, inches

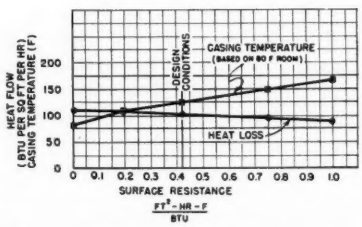


Fig. 2. Effect of surface resistance upon heat loss and casing temperature of the wall section in Fig 1

Heat Loss

Experience has shown that a heat loss of 120 to 170 Btu per sq ft hr from the boiler casing can be comfortably absorbed by the air circulating through the average boiler room. The exact value depends upon the rate of air change in the room and the percentage of the room's volume filled by the boiler.

Obviously, the mere insulation of a boiler to reduce the heat loss to a value which can easily be absorbed by the total volume of room air does not assure comfortable working conditions. Good air circulation around all parts of the boiler is also necessary to prevent the accumulation of heat in various places which must be occupied by the operators. This can be done by the liberal use of operating platforms made of grating instead of solid floors, by leaving ample aisle space between adjacent boilers, and by locating the forced-draft fans so that they help the natural circulation of air around the boiler.

Happily, good ventilation does not make a significant increase in the

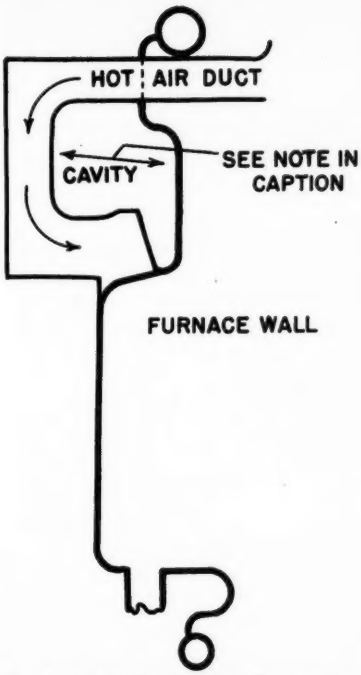


Fig. 3. Effect of opposing walls on surface heat transfer

NOTE: In the cavity neither surface loses heat by radiation since the two radiate equally to each other. All heat lost by walls must be carried away by convection heat transfer to air flowing through cavity

heat loss from the wall surface of the boiler. The heat loss by the insulation is not much affected by changes in ambient air conditions. The reason for this can be seen by referring to Figs. 1 and 2 which show the heat transfer relations for a closely spaced tube wall sealed with insulating concrete and insulated with 85 per cent Magnesia block.

The total heat flow through this wall is established in the same manner as the current flow in a series of electrical circuit. The resistances[1] of the insulating concrete, 85 per cent Magnesia block, and the "surface film"[2] are added together to give the total resistance to heat flow. Under the conditions of Fig. 1, the surface film resistance is 0.42 or 8.9 per cent of the 4.70 total resistance. A change in such a small factor obviously will not affect greatly the overall heat loss. As a specific example of this, if the air velocity were increased from 50 ft per min to 600 ft per min the surface resistance would decrease from 0.42 to 0.22.

From Fig. 2 it can be seen that this would only increase the heat loss from 100 to 103 Btu per ft²-hr. Since this entire heat loss is less than 1 per cent of the fuel input to the boiler, the change in boiler performance is negligible.

Casing Temperature

The casing temperatures corresponding to the heat loss limits of 120 Btu per ft²-hr and 170 per ft²-hr are 130 F and 150 F respectively with 80 F surroundings and a surface air velocity of 50 ft per min. Under design conditions, these temperatures certainly are within the comfort zone. However, unlike heat loss, casing temperature is influenced considerably by surface conditions. An example of this influence is the increase in casing temperature over the calculated values when two walls of the same temperature are close together, as illustrated by Fig. 3. This condition eliminates all radiant heat transfer from the wall and raises the "surface resistance" from 0.42 to 0.84. This change alone, as can be seen from Fig. 2, would raise the casing temperature from 122 to 160 even if a steady supply of air at 80 F were blown through the cavity between walls. However, in practice the natural circulation of air through the cavity would probably be inadequate and a considerable temperature rise of the air passing through the cavity would take place. This would result in a further rise in casing temperature.

Unfortunately, under these conditions an increased thickness of insulation would be of little help in reducing the casing temperature. Therefore, wherever operators must work regularly, cavities such as these must be avoided by careful boiler and building design. Aside from avoiding cavities, the precautions already listed for keeping good air circulation in the boiler room are sufficient to assure low casing temperature on a well insulated boiler.

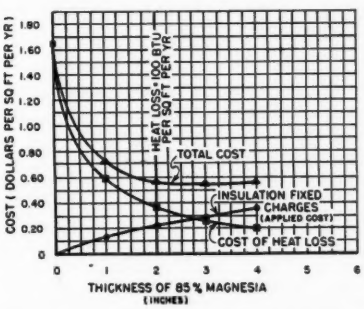


Fig. 4. Economic thickness of insulation for closely spaced tube wall in Fig. 1
Basis of calculations: 80 F room. 50 ft per min surface velocity.
Heat cost=$0.42 per 1,000,000 Btu.
Fixed charges 20 per cent

Fuel Saving by Insulating

To illustrate the economics of boiler insulation as a means of saving heat, we have plotted, for the two basic types of walls, the variation of yearly costs of insulation and heat loss against thickness of insulation. In both cases, the assumptions were as follows: (a) Room temperature = 80 F, Surface air velocity = 50 ft per min, Cost of heat loss = $0.42 per 1,000,000 Btu, Cost of insulation = applied cost per sq ft in New York City. Fixed charges on insulation investment = 20 per cent. The economic thickness is, of course, the one giving the lowest total of insulation fixed charges plus cost of heat loss.

Fig. 4 shows that 3 in. of 85 per cent Magnesia over the insulating concrete on a closely spaced tube wall will give the lowest total cost of $0.55 per ft². However, a 2-in. thickness gives a total cost only 1 cent per sq ft higher which on a fair sized central station boiler unit would only amount to about $50.00 per year. To obtain the small additional saving shown by 3 in. we would have to invest over $1000. When this factor is considered plus the fact that 2 in. was shown to be sufficient for personnel comfort, 2 in. is evidently the optimum thickness of 85 per cent Magnesia block insulation and would be the thickness actually installed.

In Fig. 5, the economic curves for

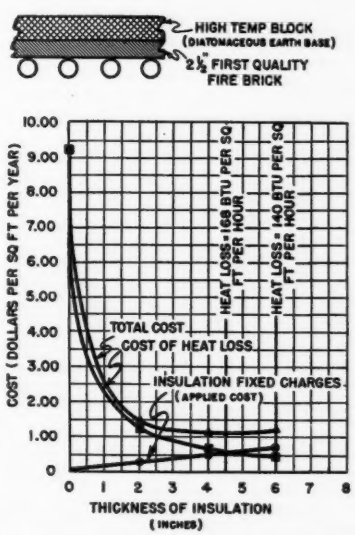


Fig. 5. Economic thickness of insulation for tube and brick wall.
Basis of calculations: 80 F room. 50 ft per min surface velocity.
Heat cost=$0.42 per 1,000,000 Btu.
Fixed charges 20 per cent

[1] Resistance is the reciprocal of conductance which is heat flow expressed as the quantity BTU ÷ (SQ. FT. × HR × DEG. F). Therefore resistance is the quantity (SQ. FT. × HR × DEG. F) ÷ BTU. This unit has no readily understandable physical significance, but the term itself is more easily understood when calculating heat flow through a composite wall.

[2] The "surface film" results from the combined effect of radiation and convection from the outside wall surface. A decrease in the temperature of the boiler's surroundings increases the temperature difference and therefore increases radiation from the surface, thereby decreasing the resistance of the "surface film." Similarly an increase in the velocity of the air passing over the surface increases the heat taken away by convection and thereby decreases the "surface film" resistance. Numerical values for the "surface film" conductance or resistance were obtained by an equation developed by Jurges for forced convection from plane surfaces with the Stefan-Boltzmann radiation formula. Curves giving values for the "surface film" can be found in the Manual of A.S.T.M. Standards of Refractory Materials (1948).

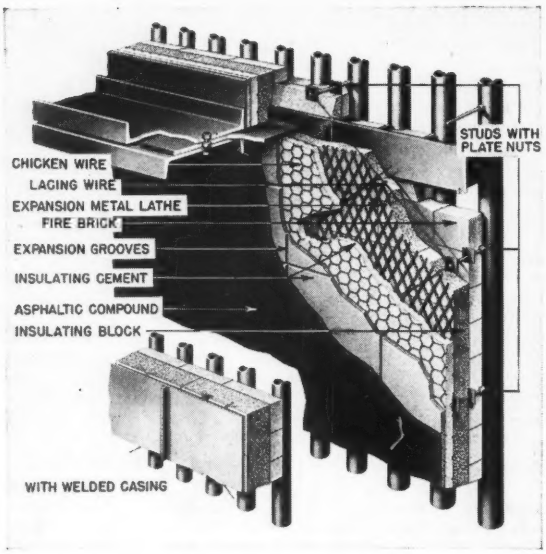


Fig. 6. Tube and brick wall

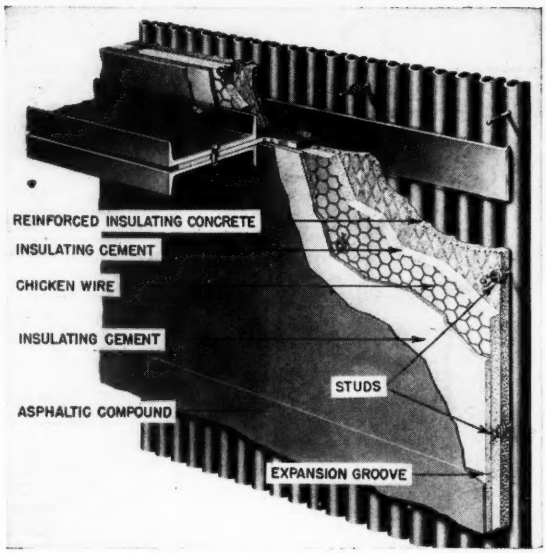


Fig. 7. Completely cooled wall

insulating a 1200 F tube and brick wall with high temperature block (diatomaceous earth base) are plotted. The curves indicate that the theoretical economic thickness of insulation is 4 in. However, depending upon boiler room conditions, from 4½ to 6½ in. are required to keep the heat flow below the maximum allowable for personnel comfort. The maintenance of reasonable comfort for operators is, of course, more important than the theoretical economics. Therefore, in practice most tube and brick walls are insulated greater than the economic thickness.

Prevention of Air Leakage

TUBE AND BRICK WALL

When a "tube and brick" wall is designed, the inner refractory lining is made as airtight as possible. Without any supplementary seal, this makes a commercially tight wall for use where the draft within the setting is fairly low. However, in high draft zones the brickwork is not sufficiently airtight. Therefore, the entire wall may be covered with a casing which is made as airtight as possible. With a casing of this type some slip seals are required to take care of relative expansion caused by a temperature differential of about 400 F between wall tubes and casing. The refractory then serves to limit the amount of leakage which occurs through the slip seals and often at casing terminals. The insulating block can be used to supplement the leakage resistance of the refractory by being laid up in two layers with all joints staggered and pointed up with insulating cement where necessary.

Recently it has been found that the need for an airtight casing can be eliminated by designing the insulation setup to make it act as an air seal. Air leakage tests on settings built in this way have been consistently as low as those for welded casings. These airtight insulation designs can be arranged so that no casing at all is required or so that they can be covered with a "veneer" casing—one which is less expensive than a welded casing because there is no attempt to seal it against air leakage.

Figure 6 shows a tube and brick wall with the insulation designed so that no casing is required. The small insert shows the construction used with a welded casing.

In the uncased construction, a single thickness of block insulation is placed outside the firebrick. High temperature diatomaceous earth block is most frequently used since it has the highest temperature resistance of the moulded type insulations and is rugged structurally. The block is tightly laced to the brick with criss-crossed lacing wires between the studs which are welded to the wall tubes on approximately 18-in. centers. The layer of block is made as airtight as possible by butting the blocks together firmly and pointing up wherever required with insulating cement. Expanded metal lath (1½ in. x 13 BWG) is placed over the block insulation and held tightly in place by plate nuts screwed on the studs. The expanded metal lath serves as an "explosion mat" to back up the firebrick in case of an explosion within the setting. The expanded metal lath is then covered with a coat of insulating cement 1 in. or more thick which is required to bury the metal lath deeply enough to overcome its tendency to bulge after repeated shutdowns and startups. Since the insulating cement has about 20 per cent shrinkage, this layer must be allowed to dry thoroughly and all shrinkage cracks must be filled in before the finish coat is applied.

Over the insulating cement, chicken wire is stretched to serve as reinforcement for the finish coat. A 19 BWG wire with about 1½ in. mesh is used in order to have enough flexibility to avoid cracking the finish coat at the joints of the wire. The wire must be stretched as tightly as possible over the insulation underneath and must be tied to all the studs. The careful stretching and securing will prevent the wire from sagging in service with subsequent buckling of the finish coat. After it is stretched and secured, the wire should be kinked out with a pliers at about 2-ft intervals. This holds the wire slightly away from the surface of the insulation and permits the finish coat to be troweled in behind it. If this is not done, the wire will not securely hold the finish coat in place and the finish coat will depend entirely upon whatever bond is developed with the insulation under-

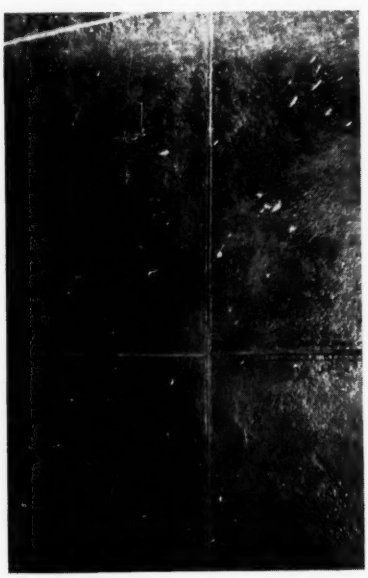


Fig. 8. Photograph of uncased wall surface

neath to prevent it from peeling off.

The finish coat is applied in two layers. The first is ½ in. of insulating cement which serves as a base for a final air-sealing layer of asphaltic compound. The cement is tough and fibrous, but by no means elastic. Therefore, it is formed into panels approximately 3 ft by 4 ft by grooving entirely through to the chicken wire. Random cracking of the surface is prevented by concentrating in the grooves the effects of drying shrinkage of the cement and of expansion of the boiler. The final ¼ in. layer is a compound of asphalt and asbestos fibres. It is applied after the first has completely dried and is troweled over the entire surface of the first layer so that it fills all the grooves. Its shrinkage is high enough so that it recedes into the grooves of the first layer, and after drying a paneled effect is plainly visible.

The asphaltic compound is the major air-sealing barrier. The asphalt gives it a reasonable amount of flexibility so it tends to bridge over and keep sealed any cracks which develop in the insulating cement in spite of the grooving. In addition, it seals the grooves and the pores of the insulating cement against air leakage.

The resulting finish is not perfectly smooth because of the shrinkage of the asphaltic compound which makes it conform to the grainy surface of the layer of insulating cement underneath. However, it should not show trowel marks if the technique of application is good. The surface can be painted any color, provided it is first primed with an asphalt base aluminum paint. Figure 8 is a photograph showing a section of the wall of an uncased boiler insulated as we have described. At the time the picture was taken, the unit had been in service for one year and had undergone about 50 temperature cycles from hot to cold by being shut down each week. No cracking is evident.

Since an uncased surface like this is easily damaged and therefore requires constant maintenance, many operators prefer that an airtight insulation arrangement be covered with a "veneer" casing. When this is done, the insulation is similar to that shown in Figure 6. However, the casing may be used as the "explosion mat" so the metal lath and the insulating cement required to cover it can be omitted. In such instances, the high temperature block insulation is made thick enough to replace the unnecessary layer of insulating cement. The chicken wire and two-layer finish coat is then applied directly to the block insulation to furnish the air seal which the veneer casing does not provide.

Completely Cooled Walls

The "completely cooled" type walls are made airtight enough by backing of reinforced insulating concrete so that they do not require supplementary sealing by the insulation to permit the use of a veneer casing. However, when this type of wall is built with no casing at all, the arrangement of finish coat is identical to that described for the "tube and brick" wall. A closely spaced tube wall without casing is shown in Figure 7.

TREATMENTS

New Approach to Secondary Treatment of Hot-Process Lime-Soda Effluent

Resinous sodium exchange with acid wash and salt regeneration offers a new method for eliminating scale-forming deposits . . . A simple, inexpensive treatment . . . Requires little attention . . . Tends to compensate for variations in control of primary softener

By LYLE B. PORTER,
Consulting Engineer, Rockford, Illinois

HOT PROCESS LIME-SODA softening has for years been an accepted and widely used water treatment for the boiler plant. With the majority of waters this has been an economical means of producing a relatively low-solids, low-hardness effluent that was quite satisfactory for boiler feed purposes.

Even under ideal conditions, however, the effluent from a hot-process softener will have a hardness of 0.5 to 2.0 grains per gallon. In poorly controlled plants, the residual hardness may be much higher. When operating on a variable raw water supply, the control of a lime-soda softener is extremely difficult and wide variations will usually be noted in the quality of the final effluent. This residual hardness is sufficient to cause serious scaling in boilers unless large quantities of after treatment are used.

Secondary phosphate softeners are being used in many instances, following hot-process lime-soda units to further reduce the hardness of the feed water. Many of the shortcomings of the lime-soda process, are still present in the phosphate softener. Close control is required at all times to properly proportion the chemical feed and maintain a low sodium phosphate concentration in the boiler water, especially if the composition of the raw water varies.

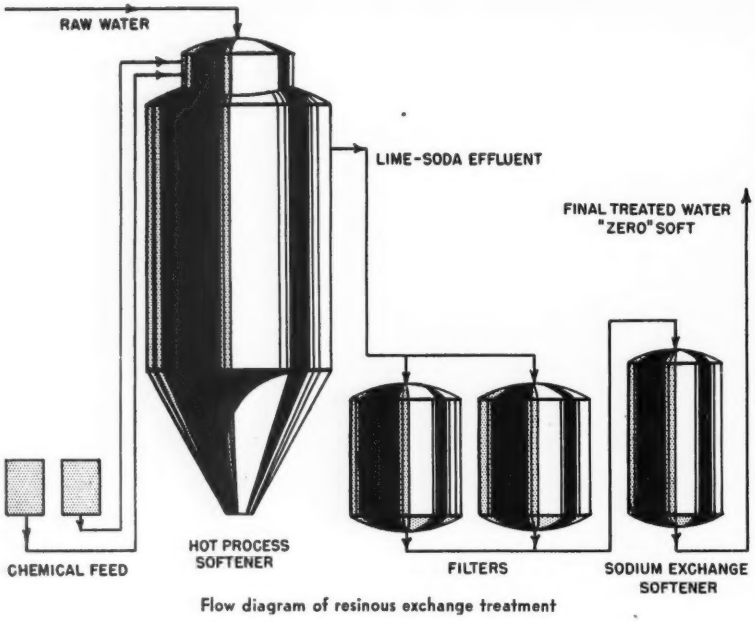
In many cases, if the feedwater alkalinity is carried sufficiently high to get good calcium phosphate precipitation, the boiler water alkalinity becomes excessive and acid treatment or excessive blowdowns must be resorted to. Even under the best of operating conditions some calcium phosphate will remain in solution in the feedwater to be precipitated when the higher temperature and pH concentrations of the boiler are reached.

Further, phosphate softeners are bulky and relatively expensive units to install and operate. They require a minimum of one half hour retention time for the water at a relatively high temperature, resulting in considerable heat loss due to radiation; also filters must be provided, thereby increasing floor space requirements.

For some time those interested in water treatment have been searching for other means of treating this hot process lime-soda effluent to further reduce or completely eliminate the scale forming properties. The most obvious approach to the problem was to sodium exchange the calcium, but this did not seem practical since the commonly known exchangers would not withstand the high pH conditions or the high temperatures encountered in this type of water.

Reports coming out of Germany† following the war indicated that they had accomplished at least partial success in applying some of their resinous exchangers to this type of work. A study of our more recently developed resins indicated that at least one of them should operate under these extreme conditions.

Preliminary laboratory tests were



Flow diagram of resinous exchange treatment

sufficiently encouraging so that arrangements were made to install a pilot plant to study the problem further under actual operating conditions. This pilot plant has been in continuous operation for the past year treating water at temperatures up to 220F and a pH of 9.5 to 10.5.

Typical analysis of the hot-process effluent water and sodium-exchanged water is shown in the table at the right.

After the pilot plant had been in operation for approximately ten weeks, it was observed that the hardness of the final treated water was 0.2 to 0.3 grains per gallon. An inspection of the resin bed showed that it was contaminated with lime, presumably from after-precipitation or filter bypass. This lime deposit had formed into "mud balls" that could not be removed by backwash.

Since the resin used will withstand both high and low pH conditions, it was given an acid wash to remove the lime. Following this a normal salt regeneration restored it to its original condition. Subsequent experience has indicated that periodic acid treatment will be necessary to keep the bed free of lime deposits. The frequency of these acid washes is, of course, dependent on the efficiency of the lime-soda softener and the filter beds.

Periodically samples of resins were removed from the pilot plant for laboratory study. These studies have shown the resin to maintain its capacity and physical stability. No appreciable loss in bed volume has been noted.

Due to the high exchange capacity of the resin and the relatively low hardness of the water being treated, equipment of this type will treat large volumes of water between regenerations. In most instances regenerations once or twice per week will be sufficient.

Typical analysis of hot-process, effluent water and sodium-exchanged water

Hot-Process Effluent				Sodium-Exchanged			
Hardness*	pH	P	M	Hardness*	pH	P	M
1.5	9.6	0.5	2.4	0.0	9.83	0.8	2.7
1.7	9.5	0.5	2.3	0.0	9.69	0.8	2.8
0.9	10.37	1.5	2.2	0.0	10.12	0.9	2.1

*All readings except pH in grains per gallon $CaCO_3$ equivalent.

Treatment Has Many Advantages

Many of the advantages to be appreciated from this type of after treatment for hot process lime-soda water will be obvious to the power plant engineer. Here are a few of these advantages:

An auxiliary treatment that requires a minimum of attention and control, but one that tends to give uniform results and automatically compensates for variations in the control of the primary softener. This could mean, in many cases, less frequent testing of the lime-soda unit and fewer changes in its control.

A stable "zero" soft water supply at all times regardless of variations in the hot process effluent. With all scale forming salts removed or reduced to a minimum, there would be little danger of scale deposits in feed lines, pumps, preheaters, or in the boiler, resulting in lowered maintenance costs. With no scale in the boiler, greater heat transfer and higher efficiencies would be obtained.

The possibility of carrying a lower chemical excess in the effluent from the hot process softener. This would mean a lower alkalinity and a slightly higher hardness water, but the increased hardness would be removed by the base exchange resin.

A minimum amount of after-treatment required to maintain proper boiler water conditions at all times. The use of reduced amounts of after treatment would result in less dissolved and suspended solids in the boiler water and, consequently, less blow-down would be required. In certain cases, already under consideration, chemical savings alone will pay for the new softener in a short time.

The operation of a sodium exchange unit is inexpensive. The only chemical required is salt.

In this process the use of acid is avoided in any way that could result in an acid feed water condition due to failure of control equipment or human error. The periodic acid washes given the resin are followed by the conventional salt regeneration which removes all danger of equipment damage.

Silica reduction, if necessary, can be obtained equally well whether a sodium exchanger or a phosphate softener is used for secondary treatment.

†Cerna, W. W., *Proceedings Seventh Annual Water Conference*, Engineering Society of Western Pennsylvania, 1947.

EMULSION EXTINGUISHMENT of Oil Fires With Water Sprays is fully demonstrated with spectacular fires in full color, and a running commentary with explanation of how and why it works in scenes photographed through the microscope for a 16-mm, *sound*, Kodachrome film announced for distribution by Grinnell Co., Inc. It is available for free showing. Write to General Sales Manager's Office, Attention: K. P. Jones, Grinnell Co., Inc., Providence 1, R. I.

ATOMICS

Radiation Detection For Health Protection

By EVERETT W. MOLLOY and ARNOLD O. BECKMAN

Instrument Division, National Technical Laboratories
Pasadena, California

IN THE USE of atomic energy and radiochemistry there are four types of radiation to guard against. These are: (1) Alpha particle radiation, (2) Beta radiation, (3) Gamma rays, and (4) Neutron radiation.

Nearly all the common radiation detectors depend upon the phenomenon of ionization. The simplest of all detectors, and historically the earliest, is the ionization chamber. In its typical form this consists of a closed cylindrical tube with a small rod passing through the center but well insulated electrically from the chamber itself. The chamber must be made of conducting material and the center rod must also be a conductor. If a potential is established between the chamber and the rod the charged particles produced by the ionization of the gas in the chamber volume will migrate toward the chamber wall or *collectrode* under the influence of the electrostatic field. If then the chamber is placed in a radiation field, the current flowing between the electrodes will be a measure of the radiation field intensity. Ionization chambers are used mostly for detecting beta and gamma radiation and sometimes for detecting alpha particles from *surface contamination.*

Another type of radiation detector is the Geiger tube. These are very sensitive devices and with them single electrons can be detected. The most common design consists of a glass tube ½ to 1 inch in diameter with a 0.002 to 0.005-inch wire stretched axially through the center of the tube. The inside of the tube is coated with a conducting material. The device is pumped and permanently filled with a rare gas to about 1/30 of an atmosphere. A potential of 1000-v is produced between the wall and the central wire, the latter being made positive. In action the tube is a trigger device. If a free electron is formed within the tube it is drawn toward the positive central wire. Under the influence of the high-voltage gradient near the wire the electron soon has sufficient kinetic energy to ionize a neutral gas molecule on collision. Then the two free electrons accelerate toward the center wire and again cause ionization by colliding with other gas molecules; this process being repeated again and again. Thus the resulting current to the central wire may consist of several millions of electrons, a veritable avalanche. The output of such a tube consists of a sharp electrical pulse of constant amplitude independent of the initiating ionization. Geiger tubes are highly sensitive and hence useful at very low levels of radiation intensity.

Proportional counters are modified Geiger tubes, the difference being that the signal output of this detector is proportional to the initial ionization. If a Geiger tube is operated at a potential just below the Geiger region the device will not produce pulses of equal size for all ionizing rays, but the size of the pulses will be proportional to the initiating ionization.

Photographic films are often used to detect nuclear radiations. These films are sensitive to all radiations that produce ionization directly or indirectly and are used to accumulate a record of the users exposure over a relatively long period of time.

Crystals such as diamonds and zinc sulphide can be made to count in the same manner as Geiger tubes and perhaps a suitable crystal will eventually replace the Geiger detector.

Scintillation counters use a phosphor material in which the incident radiations produce very weak flashes of light which can be detected by a photomultiplier tube. This type of detector, however, is not yet ready to take an important place in health physics work.

Actual detecting instruments are divided into two general groups: (1) Direct reading rate meters. Instruments that fall into this classification are those which give a direct indication of the radiation intensity. (2) Accumulator type instruments. These instruments indicate the quantity of radiation received during some time interval.

The first group includes ionization chambers, Geiger counters, and proportional counting instruments. The second group includes, quartz-fiber electroscopes; dosimeters, a form of electroscope about the size of a fountain pen that can be worn in the pocket; pocket chambers, similar to dosimeters but without the built-in electroscope; pocket alarms; film badges and rings. The latter contain a strip of photographic film.

In addition to these general type instruments a number of special instruments such as hand counters, foot counters and air monitors are available.

The above article is an abstract of an article in the September issue of ATOMICS Magazine.

As previously announced, the ATOMICS section which previously appeared as a section of Power Generation since October 1945, is now being published as a separate new monthly publication.

The new ATOMICS represents a greatly expanded service to those who are interested in the theory and application of nuclear energy. It will keep readers abreast of what is happening in the field of atomic power development, in the industrial applications of radioactive isotopes, and in the use of nuclear energy in medicine, biology and agriculture. The September issue, in addition to the article abstracted on this page, contains other material of atomic interest including the fourth installment of the course in Nuclear Power Engineering which started in the June issue.

If you are interested in seeing this new magazine regularly, send in the attached coupon for a free copy. You will be under no obligations for this. ATOMICS will be published monthly, and as has been true of the articles which appeared in the ATOMICS section of Power Generation, the articles will be kept on a practical, understandable level.

ATOMICS

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Power Generation

SHOWS HOW

THEY FIX THE BIG STUFF

TO POWER PLANT maintenance men in big power plants, every day is peak load day. The 554 men on the maintenance staffs of The Detroit Edison Co's. four great plants see to it every hour that there's enough kilowatt-hour-making equipment ready for work.

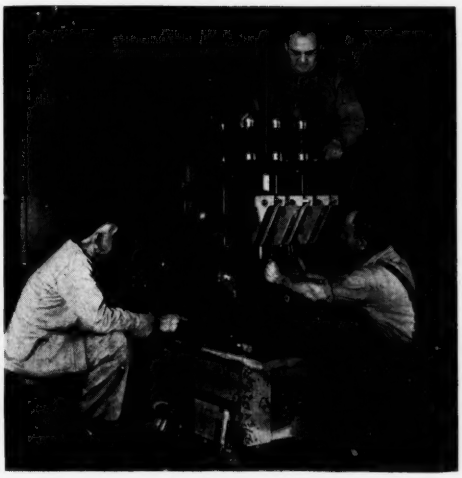
Through the lenses of the top-flight photographers of the company's Photographic Division, by courtesy of the Detroit Edison *Synchroscope*, you see those top-flight maintenance men in action.

Loosening slag inside Delray's No. 10 boiler. Left to right: Bob Swan, Mike Moritz, Supervisor Dick O'Neil. Five stories up in the superheater tubes, others were making careful inspections. Still others were hard at work on fans and air heaters

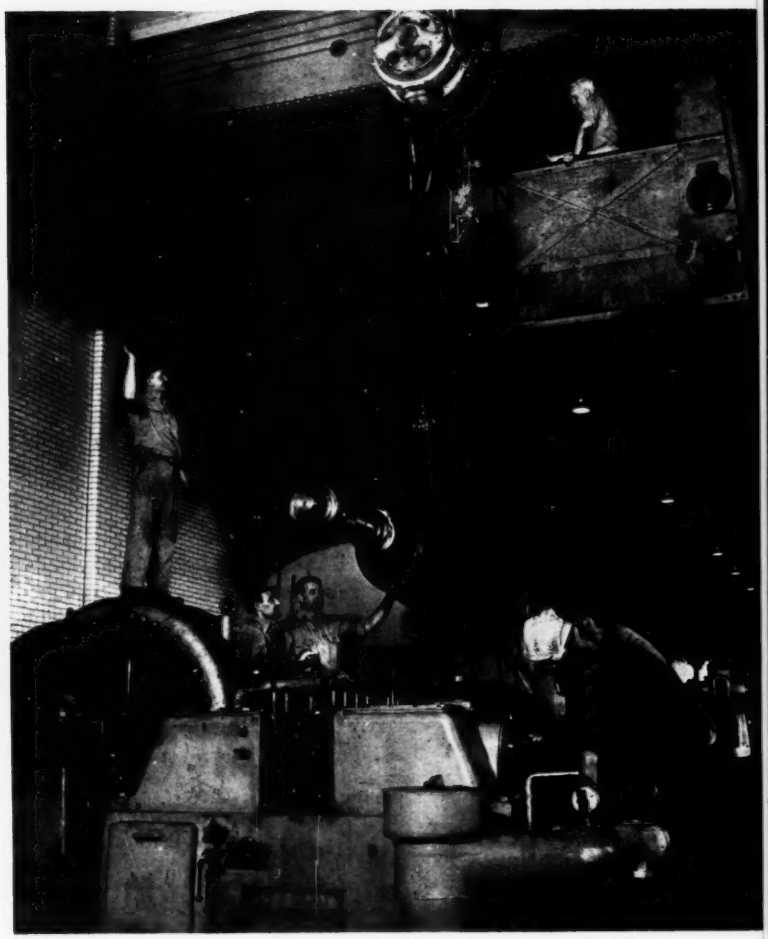
Some of the biggest stokers now in operation are at Delray Station. Here are Delray stoker repair men, left to right, Ernie Petrie, Mac McLaughlin, Bernie Smithee and Art Moen

Maintenance men John Lynch, left, and Ed Fournier use torch to fasten steel screens to Trenton coal breaker. This is the huge revolving screen that breaks the coal to uniform size for further pulverizing

NEWS REEL



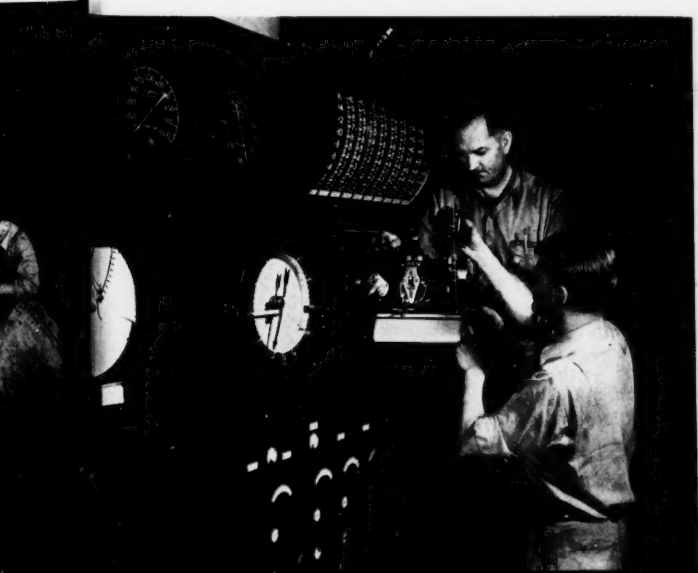
One day a simple light switch, next day a half-ton power plant switch. Trenton Channel electrical crew, from left: Bill Bennett, Roy Gillman, Merrel Amprin

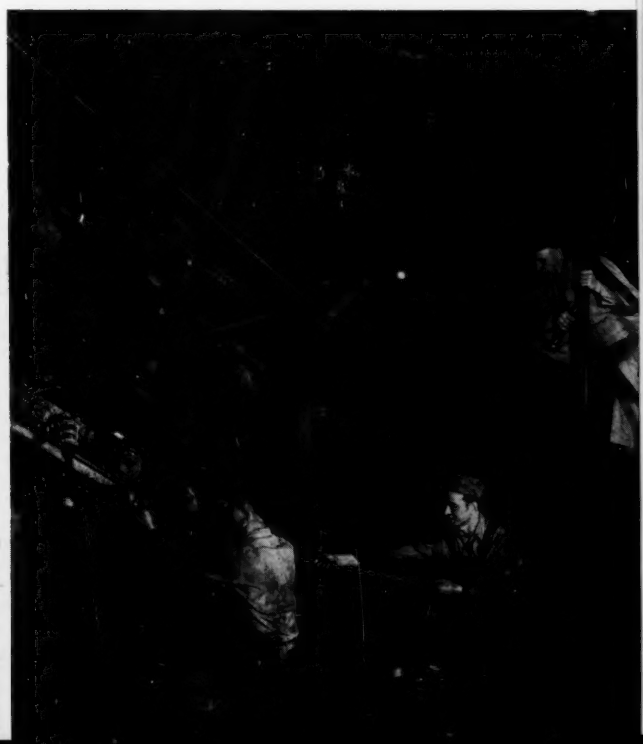


(Right) At Delray, Foreman Al Lindberg signals to Harold Sidebottom in crane cab, who inches turbine rotor cut carefully for repair. Others, left to right, Don Cook, Harry Decker, Walt Beck

(Right) Here's where Conners Creek coal starts a long conveyor climb to bunkers. Sam Blaga takes up slack so George Bennett can fix worn wheel. On stairs is Asst. Maintenance Engineer Dick Benoit

(Below) From the coal breakers and stokers to the instruments, which are the eyes of the power plant. Here Conners Creek instrument men Clyde Holmes, left and Rene Vermeersch adjust a recorder on the boiler panel





Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—HERE'S HOW IT WORKS

YOU HAVE a question about some detail of power plant operation, maintenance, design. You can't find the answer in your own experience nor in the books. So you write in to our editors. If we know the answer, we send it right back to you. (Maybe we don't know the answer either, but we usually know where to get it for you.)

In any case, we publish your question, signed only with your initials. We do not reveal your identity.

Dozens of engineers write in to us, giving their answers. We forward you copies of the replies as soon as we get them.

You, too, co-operate with other engineers by answering their published questions in the same way.

Then, so far as space permits, we publish those replies as soon as possible, so that everybody will learn what the others know about the problem. We pay well for all answers published. And those who answer get credit for knowing.

Simple, isn't it? And effective? Just ask the power engineer who has tried it!

Engineers who take the trouble to answer your question would appreciate some information from you, transmitted through the Q & A editor, on how their answers helped solve your problem. In doing this, indicate whether or not your comments could be published for the benefit of all readers.

Answer No. 445

WHAT TREATMENT PREVENTS SCALE AND CORROSION IN DRINKING WATER SYSTEM?

WITH REFERENCE to the request of J.W.B. (Question No. 4) for information as to whether materials such as sodium tetraphosphate, which can be purchased on the open market, may be used in water treatment for human consumption without infringement of any patents, the answer is, Yes!

In a number of important cases the United States Supreme Court has held that a patentee has no right to control the sale of unpatented chemicals or materials such as salt tablets used in dispensing machines (Morton Salt Co. v. G. S. Suppiger Co., 314 U.S. 392), or glue used in machines for gluing shoes (United Shoe Machinery Corp. v. United States, 258 U.S. 451).

Even if some manufacturer should hold a patent for some special apparatus or method of treating the water with a specific chemical such as sodium tetraphosphate, his patent monopoly would not extend to the sodium tetraphosphate or any other chemical which might be used in the patented apparatus or process.

Engineers and manufacturers not familiar with our patent laws will find an interesting and instructive treatise in an article entitled "Patents and the Courts—Reform or Revolution?" in *Mechanical Engineering*, March 1949, pp. 224-233, by H. A. Toulmin, Jr., a prominent patent attorney and mechanical engineer. We earnestly urge all readers of POWER GENERATION to acquaint themselves with the changes which our Supreme Court and other Federal Courts have made in our patent laws in the past 15 years.

Since Questions No. 1 and 2 primarily relate to corrosion we suggest that J.W.B. first determine what factors are causing such corrosion. These are three common causes:

1. Acid.
2. Electrolysis.
3. Dissolved gases, particularly oxygen.

Since Question No. 2 is specifically directed to oxygen, J.W.B. may find that mechanical deaeration will give better results and be more economical than any chemicals even if such are available.

Oxygen can be removed by thoroughly agitating the water in such a way that all parts are brought to the surface or the water may be discharged in thin sheets or through spray nozzles so that all parts of the water are exposed to the atmosphere in such a manner that the atmosphere contacting the water does not contain water vapor at any appreciable partial pressure due to the oxygen which is sought to be removed.

Oxygen also can be removed by evaporation in special equipment or by agitation with steam instead of by mechanical means. In any event, the agitation must be such that sufficient water vapor is removed to carry the oxygen away as fast as it is liberated and thus prevent a building up of any appreciable partial pressure due to the presence of oxygen. Open and closed types of deaerating heaters are available.

When considering drinking water there is one important point which must be considered and which often is overlooked by both private and municipal authorities — palatability. No one likes to drink water that doesn't taste good and in many instances water that has been softened or has the oxygen removed makes a very poor drink. Several years ago the city of Maywood, Ill., obtained its water from artesian wells which furnished excellent drinking water but extremely hard—about 34 grains per gallon permanent hardness. A municipal softener was installed which materially reduced the hardness but also destroyed the palatability. Only by keeping the water at a temperature below 40 F was it fit to swallow. J.W.B. should consult expert water treatment engineers for any final answer to his problem.

Dallas, Texas — J. R. DARNELL

Answer No. 446

WHY IS THIS CIRCUIT GROUNDED THROUGH A FUSE?

HE HAS a 220-v, 60-cycle, 3-phase power circuit in his plant, said W.T.C., on which line L2 is grounded through a fuse. Voltmeter readings to ground are: L1, 220 v; L2, 0 v; L3, 220 v; L1 to L2 and L2 to L3, 220 v.

Why was this circuit grounded through a fuse? Should this ground be solid?

Well, there seems to be general agreement among the answers that a solid ground WITHOUT a fuse and WITH ground lamps, is the correct procedure. Instructions are given for installing the ground lamps.

Ground Detector and How to Install It

THE LINE is grounded through a fuse under the impression that it will limit voltage on the system to a low value in case of lightning or transformer breakdown where the high tension wires might touch the low tension lines. This might also have been done so that the fuse might act as a ground detector, by allowing enough current to flow to another grounded wire to "burn off the ground," the fuse being only large enough to allow 20 or 30 amp to flow.

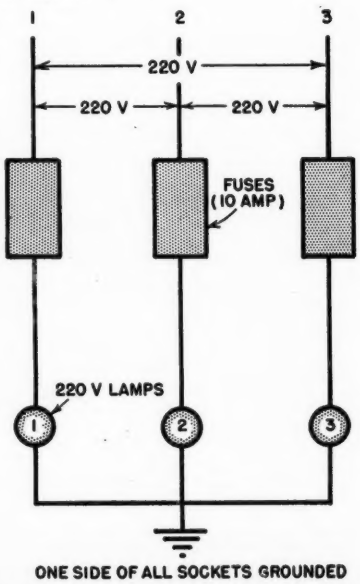


Diagram by Hope showing how ground lamps form a ground detector

I have worked on several 220-v, 3-phase systems, none of which were grounded because it was considered unnecessary, but in each case a ground detector was used to show a ground and steps were taken to clear it if one occurred.

The ground detectors are simple to make with three porcelain sockets mounted on the switchboard, protected by fuses as shown in the diagram.

If a ground occurs anywhere on the system (i.e., on line 1) this puts full voltage across lamps No. 2 and No. 3 to light them brightly while lamp No. 1 goes out. If a partial ground occurs, lamp No. 1 will not go out entirely and lamps No. 2 and No. 3 will not burn at full brilliancy. Normally, all three lamps burn at about ½ normal brilliancy.

This arrangement limits the current flow to ground to a low value in case of a grounded wire on the system, and is very quickly noticed by an operator.

Chelmsford, Mass. C. W. HOPE

Solid Ground, says Chace

A GROUNDED PHASE should always be a solid ground and not through a fuse for safe practice. It is not good practice to ground one leg of a 3-phase power circuit when delta or open delta transformer connections are used. If W.T.C. would complete his readings, his question would be a lot clearer, for as it is stated in the question, it could be either the 3-wire Edison circuit or 3-wire 2-phase, although he states it is 3-phase.

Sacramento, Calif. PATRICK H. CHACE

Code says Ground (Except Cranes) But NO Fuse

ACCORDING TO Rule 2514 of the National Electrical Code, the service *should* be grounded if the system can be grounded so that the maximum voltage to ground does not exceed 150 v; and it is *recommended* that the system be grounded where the voltage to ground does not exceed 300.

The grounding should definitely be solid, *not* through a fuse, and through a conductor of code size. Any one of the phases can be grounded. A preferable grounding point is the center tap of one phase. This is preferable because it reduces the maximum voltage to ground from 220 to 190 v. However, if a fourth wire is not brought in from the transformer bank it will not be possible to ground at this point.

An exception to the grounding requirement occurs in the case of circuit for electric cranes operating over combustible fibers in Class III hazardous locations. These circuits are not grounded, for the hazard of fire caused by a spark produced when a hot conductor accidentally touches ground is considered greater than the hazard of exposure due to trouble in the stepdown transformers or to lightning.

Iola, Kans. EDGAR A. COOPER

Answer No. 447

WHY DID MOTOR ROTOR OPERATE OFF CENTER?

WHEN INSTALLING three new 300-hp, 2700-v, 3550-rpm boiler feed pump driving motors recently, P.M. had the following experience with one of them. The rotor of the motor had a ⅜ in. "float." When the electrician was connecting and checking the motor for rotation, the rotor shot hard over to the end away from the pump. After the coupling was made up and the unit started, the motor went hard over the opposite way towards the pump end.

Why, asked P.M., didn't the motor rotor find its magnetic center somewhere in the ⅜-in. float space? Where was the magnetic center? Should the magnetic center be the same with and without load?

The pump was operated for about 24 hr with the motor rotor hard up against the face of the pump end bearing. But the bearing ran too hot and finally they had to shut the unit down.

Meanwhile, the other two pump motors, similarly installed, were all right, did not operate off center like this one.

Coupling May Have Pulled Rotor Off Center

I AM ASSUMING that P.M. knows that the motor and pump are properly aligned and that he rechecked his alignment following the trouble.

Any electric motor has a definite magnetic center and, when sleeve bearings are used, a certain amount of "float" is provided to allow the rotor to seek its center. In the process of coming up to speed, it is not unusual for the rotor to swing or hunt quite sharply before it finally settles down on magnetic center. That is, the rotor will settle on magnetic center unless held at either extreme of its actual swinging by some outside force. This force need not be very great, since the magnetic pull tending to establish a rotor on magnetic center is not particularly great to begin with, and it decreases the closer the rotor gets to center.

On the initial start, before the coupling was connected, I suspect that the rotor initially swung away from the pump hard enough to be noticed.

After the coupling had been made up, the rotor swung in the other direction and was held there because

"Actually, except for us maintenance men, this power plant runs itself—what the Hell they need a superintendent for beats me!"

of excessive friction within the coupling. The motor half of the coupling easily slid toward the pump on starting up but, as the motor speed and torque increased, the motor half of the coupling was held in this extreme position.

It is not unusual to see an undersize coupling, an improperly lubricated coupling, or a damaged coupling hold the motor rotor in a particular position rather than allow it to move freely and adjust itself to its normal operating position. Apparently the coupling size in this particular instance is correct, since the other two motors are giving no trouble. The next step would be to see that the coupling is properly lubricated; if not, a new coupling should be requested.

The bearing temperatures are bound to be higher than normal, since the shaft shoulder is undoubtedly working against the edge of the babbitt causing a metal-to-metal contact. This might eventually wipe itself in, but chances are better that the bearing would eventually fail due to high temperatures.

The magnetic center of the motor in question is very likely about in the middle of the ⅜-in. shaft "float," even though indications were that it was elsewhere. Motors are tested for proper magnetic center before being shipped by the manufacturer and it is usually located by a scribe mark on the shaft at the edge of the bearing housing on the shaft extension end. This location of magnetic center is permanent for that particular machine and does not change with the load.

Minneapolis 13, Minn. J. H. JONES

Shift Rotor on Shaft Small Amount, says Thomas

"MAGNETIC CENTERS" of the rotor and stator of this motor are probably in their correct position, but I believe they are prevented from occupying the same axial point. There is an appreciable axial force tending to realign displaced magnetic centers in a loaded induction motor. Your pump-end thrust bearing, in resisting this force, is being well overloaded.

If this is the case, the remedy is to relocate the rotor assembly a short distance down the shaft. A shift of a fraction of an inch is usually not too severe a problem. In this motor, the rotor is to be shifted in the direction of the hot bearing; i.e., toward the pump.

As far as I know, the magnetic center remains in the same position regardless of load. I believe, however, that the tendency to resist an axial deflection is somewhat proportional to the motor loading. Starting and sudden load changes are transient conditions, and can be expected to temporarily and axially disturb the rotor position. Variations in design will contribute one way or another to this condition too.

Norfolk, Va. W. N. THOMAS

Answer No. 448
WHAT MAKES TURBINE NO. 2 DROP LOAD AND LOSE VACUUM?

Two 750-kw condensing turbine generators are installed in his plant, said L.R.D. in the August issue. Turbine No. 1 exhausts to a single 2400-sq-ft surface condenser and will carry its rated load at 165 psi throttle pressure, 27 in. vacuum, with condenser circulating water at 85 F. Turbine No. 2, however, exhausts through a Y connection to two identical 1700-sq-ft condensers in parallel but at full throttle pressure will carry only 400 kw load and with the same condensing water temperature, 85 F, the vacuum drops to 23 in. With throttle steam pressure of 145 psi, the unit will carry up to 500 kw and maintain 27 in. vacuum but if the load and throttle pressure are increased beyond this, the load and vacuum both begin to drop.

Since this must be corrected in view of an expected increase in factory load, L.R.D. wants to know what troubles to look for and how to cure them. Turbine blades are in good condition, he says, there are no air leaks in the vacuum system and the condensing water supply is ample.

Here are some suggestions from readers. Perhaps Oscar the Gas Works Owl could help on this one.

Obvious Causes May Be Overlooked, says Hudelick

TO GET a good answer, one of the good engineers like the ones you write about, such as the "Old Chief," should make a trip down and he would spot it in 5 min. Anyway, here goes:

1. Be sure that the cooling water goes in the bottom of each of the two condensers and out the top.
2. Be sure there are tubes in the air-ejector condenser and that they are tight and not corroded out.
3. Be sure the water side of the condensers is clean.
4. Be sure there are no obstructions in either pipe line or in either condenser.

Believe it or not, I have seen all these causes of condenser trouble in various plants.

Portland, Ore. O. L. HUDELICK

Editor's Note—Without doubt this is a job for Oscar the Gas Works Owl. If there aren't any tubes in the ejector condenser, he will surely find out. We'll see if John Raven can spare him to help a fellow engineer out of trouble.

Check Glands, Condensate Pump, Tube Leakage, says Avant

I SUGGEST that the high and low-pressure sealing glands be inspected on this turbine.

L.R.D. does not mention any rise in height of water in the gage glass on the condenser outlet cone. If there is no gage glass, I suggest that one be installed. This will give an indication of whether or not the condensate pump is removing the water from the condenser. If the condensate pump is not removing the water, the gage glass will show full; this water inside the condenser will rise so high that it will foul up the intake to the steam jet air pumps; this will cause the vacuum to drop.

I also suggest that L.R.D. check the speed of the condensate pump. Also make a temporary connection to the condensate pump line whereby part of the condensate can be dumped at a lower level. This decrease in pumping head of the condensate pump will generally relieve any excess amount of water.

Further, the condenser should be tested to determine if there are any tubes leaking. In general, plants using fresh water for cooling pay very little attention to condenser leakage. But if the circulating water is salty, condenser leakage can give you a lot of grief.

In case L.R.D. does not clear up his trouble, kindly tell him to send me a sketch of his layout and I will be glad to give him further comments.

Wilmington, N. C. GEORGE G. AVANT

Check Condenser Circulation, Pipe Flow, Ejector, Temperatures

IT LOOKS as if the circulation of the condensers for the No. 2 turbine should be investigated to see that all parts of the tubes get their portion of the cooling water and the steam. Condensers are sometimes defective in this respect. It seems as if with increased load there is a choking of either the steam or water circulation.

The piping between the turbine and the condenser, also between the condenser and vacuum pump, should also be very carefully investigated to see that the flow in each part is free from choking or interference by reason of the flow from the other branch.

Again the capacity of the steam jet air ejector and condensate pump may be too low, due to lack of size or to wear of the jets and throats.

A series of temperature readings on the discharge water from each of the condensers may furnish clues as to what is happening.

Piney River, Va. IRA A. BUTCHER

Answer No. 449
WHAT OPERATING DATA SHOULD BE LOGGED FOR A 1250-KW CONDENSING TURBINE GENERATOR?

HE HAS the problem of determining what data should be logged, and how often, on a 1250-kw condensing extraction turbine generator with controlled extraction, said R.B.D. in the September issue.

Here is a helpful suggestion from our old friend John F. Slavinsky, with samples of his own log sheets.

It seems to us that the solution to this problem always depends on what might be called the "philosophy" behind the log sheet. Here's what we mean.

Is the object of keeping the log to obtain records for cost accounting

purposes? Or is it primarily to keep the operators alert, so that if any operating conditions change, they will be noted soon enough for action to be taken? Do the operators have recording instruments and do they watch the charts closely enough to detect trouble before it will show up on the log sheet? And so on—a number of such questions can be asked, depending on individual plant conditions.

For a good discussion of some of these points, see Why Keep Boiler Room Logs, by K. H. Mack, POWER GENERATION, August 1948. Everything said in that article about boiler room logs applies equally well to turbine room logs.

Typical Log Sheets from Slavinsky

In answer to R.B.D.'s question, I am enclosing log sheets we use in our power plant. This of course includes all of our equipment, noting that number 1 turbine generator column is for a bleeder condensing type turbine. He may also add, if he wishes, bearing oil temperatures and the inlet and outlet cooling water temperatures.

As you will see, we take readings every two hours around the clock, which in our case is sufficient. Log readings every hour of the day would only involve additional bookkeepings; and as far as our experience is concerned we abandoned hourly readings some 10 years ago.

We also keep a separate log sheet for the boiler room so that the firemen know just how the conditions are in that department. I am enclosing this also. They both can be incorporated into a single log sheet if the need arises.

Rochelle Park, N. J.

JOHN F. SLAVINSKY

ELECTRIC GENERATING RECORD

DATE _____

TIME	NO. 1 TURBO-GEN. 480 V.A.C. READING INT. W H METER	AMP	KW	BLDR. PRES.	EXH. PRES.	NO. 2 TURBO-GEN. 480 V.A.C. READING INT. W H METER	AMP.	KW	EXH. PRES.	NO. 3 ENG. GEN. 240 V.D.C. READING INT. W H METER	AMP.	EXH. PRES.	M.-G. SET AMPS.	FEEDERS NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6	MILL VACUUM
12 MD																				
2																				
4																				
6																				
8																				
10																				
12 N																				
2																				
4																				
6																				
8																				
10																				
12 MD																				

TOTAL A. C. GEN. KW H.
TOTAL D. C. GEN. KW H.
TOTAL A. C. & D. C. GEN. KW H.
KW H PER LB. FUEL KW H.

OPERATING ENGINEERS
10-6
6-2
2-10

REPORT ALL REPAIRS NEEDED IN THIS SPACE

BOILER ROOM RECORD

DATE _____

TIME	PRESSURES STEAM PRESSURE	F. W. PRESSURE	(DRAFT IN. H_2O.) OVER FIRE	WIND BOX FRONT	WIND BOX REAR	TEMPERATURES FEED WATER LEAVING HEATER	FEED WATER LEAVING ECON.	FLUE GASES ENTERING ECON.	FLUE GASES LEAVING ECON.	STEAM FLOW NO. 1 BOILER POUNDS PER HOUR	FUEL BED LINK GRATE SETTING AGITATE	LINK GRATE SETTING PUSH	SECONDARY RAM SETTING S.R.	SECONDARY RAM SETTING N.R.	ASH DISCHARGE PLATE SETTING	FUEL USED
12 MD																
2																
4																
6																
8																
10																
12 N																
2																
4																
6																
8																
10																
12 MD																

TOTAL STEAM GENERATED LBS. CO_2
TOTAL FUEL FIRED LBS. 10-6
ACTUAL EVAP. LBS. 6-2
BOILER WATER TESTS 2-10
ALKALINITY SULPHATE CONC.
CHLORIDE PHOSPHATE
OXYGEN SANTOSITE
HEATER ALARM TESTED 2 P.M. FOUND O.K.
SIGNED:
OPERATORS
10-6
6-2
2-10
COAL CARS REC'D

REPORT ALL NEEDED REPAIRS HERE

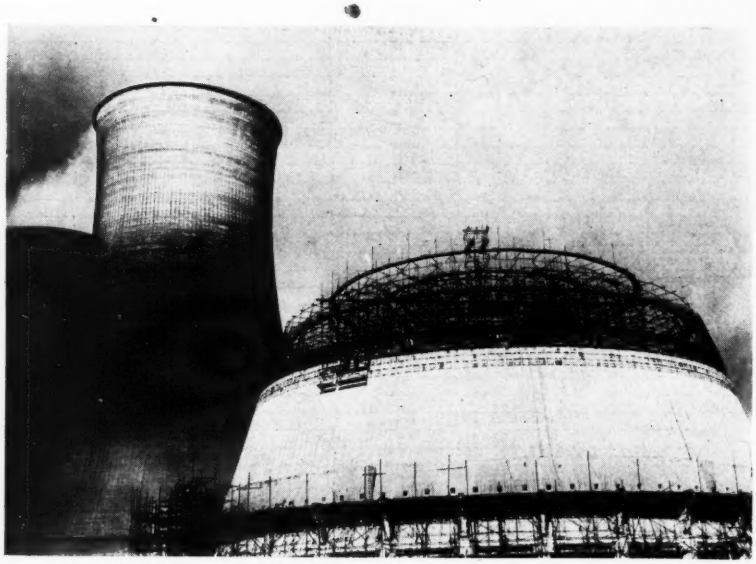
Log sheets used in his plant, as submitted by John F. Slavinsky. Note that his No. 1 Turbine-Generator set is similar to the 1250-kw condensing extraction set of R.B.D.

Britain's Industrial Power

By GEORGE DARLING

Industrial Correspondent to the British Broadcasting Corp.

SINCE WORLD WAR II, during which Britain had to close down on the building of new power plants, she has been speeding up on the plans prepared during the war for a vast expansion of power calling for 25 new steam-driven plants — in some cases double their present capacity—and a score of hydro-electric schemes in the Scottish Highlands and North Wales. By 1952 Britain's output of electricity will be two-thirds greater. Two of these staions are already in operation, although work on them has not been completed, and another is virtually finished. The first was opened in February at Meaford, near Stoke-on-Trent, Staffordshire, the second at Kingston-on-Thames, near London, in October and the third at Ipswich, Suffolk, at the end of 1948. Work is well advanced on three more stations at Glasgow, Scotland, Birkenhead, in the north of England,



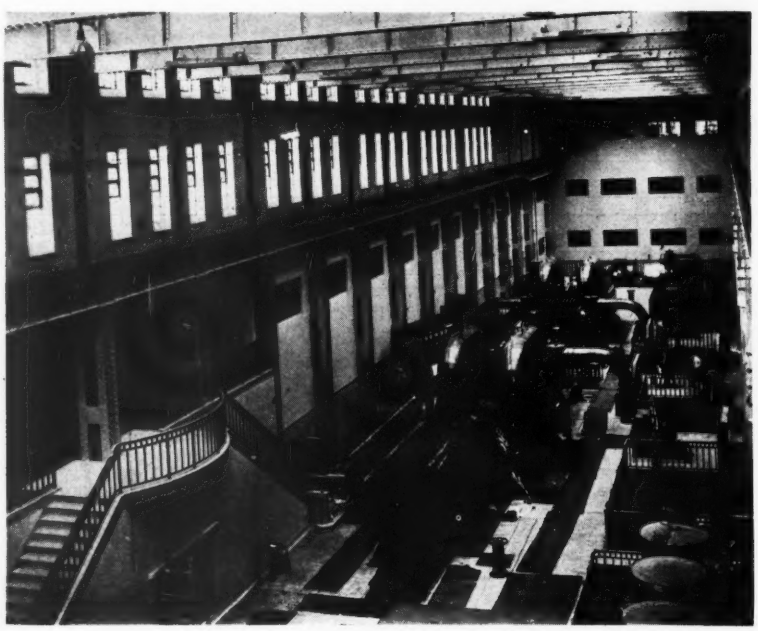


Fig. 1. (Above) Lack of continuous supplies of condenser circulating water in many parts of England make necessary the use of these large cooling towers. This view shows an additional cooling tower being erected at the Hams Hall Station near Birmingham

Fig. 2. (Left) A view of the turbine room at the new power station at Kingston-on-Thames just before the official opening. This station will have an ultimate capacity of 120,000 kw

and Croydon, Surrey. Another ten are under construction, and two more are in the early stages, including a station at Newport, Monmouthshire, for 720,000 kw and another at Carrington, Manchester, for 360,000 kw.

There is not much scope for water-driven power plants in Britain. Only in the north of Scotland and North Wales are there natural conditions suitable for producing electricity from a fall of water. When every possible dam and power station has been built in Scotland—about 20 in all—the electric power they will

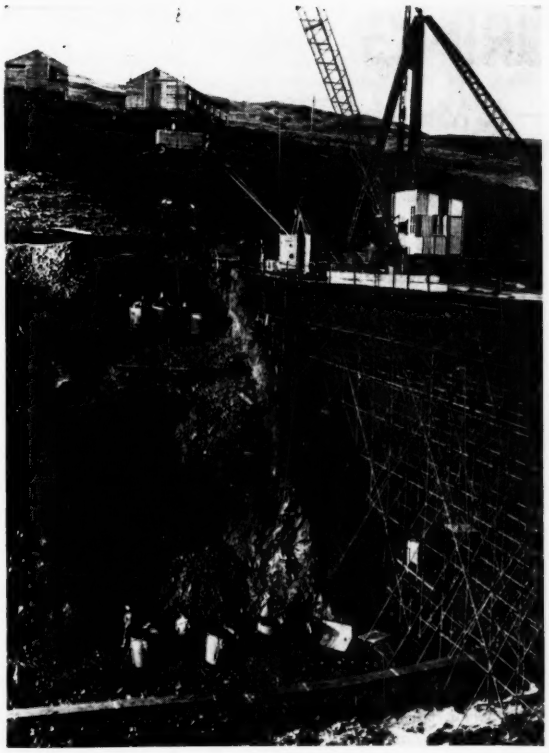


Fig. 3. An example of a hydro station working on a small volume of water falling from a good height being built at Nostie Bridge, Lochalshe, Ross-shire in Scotland. When completed the dam will be 50 ft high and store enough water to generate 1,800,000 kwh annually from a single 500-kw alternator

provide, will supply less than a tenth of Britain's total output, and the North Wales hydro-power projects are on a considerably smaller scale. So Britain's main source of power—until the Atomic Age arrives—will continue to be coal, turned into electricity in steam-driven power plants.

The whole of Britain—apart from the Scottish Highlands and a few other isolated rural areas—is already covered with a network of power-lines, sweeping over fields, forests, towns and villages on high pylons, and known to everyone as "the grid." The 25 new plants are being built to feed more power into the grid, and in the north of Scotland the grid will be extended to cover every hamlet and crofter's cottage, so that the first charge on Scotland's new hydro-power will be the development of the Highlands.

Finishing Stages

The first stage in the national development scheme will be completed in 1952, but many of the new and extended plants will come into full operation in 1949 and 1950. Some industrialists, whose operations have been curtailed now and again by power cuts, have grumbled about the time taken to build a modern power station with a capacity of, say, from 250,000-350,000 kw. It takes at least three years, which means that the first new post-war plants, which were begun as quickly as possible after World War II, are only now reaching the finishing stages. But the grumblers are silenced when they learn more about the tremendous efforts that have been made to speed-up the building and equipping of new plants, despite all the post-war obstacles.

One of the biggest checks to speedy building is that it is the British practice to build individual power-plants. Until a year or so ago there had been no standardization, and for a good reason: each plant had been designed to use efficiently the type of coal found nearest to the plant, and because coals differ remarkably in their heat-producing and ash contents, every British power-plant is an individual job. No two are alike, but all are built for the highest efficiency at the lowest running costs, using local fuel.

Some standardization of equipment has recently been introduced. Steam-raising equipment is now designed to use the lowest quality coal, almost mine-dirt in fact, and only two sizes of generators are built for home use, though the electrical-gear manufacturers are still making individual sets for overseas countries.

The manufacturers have had to contend with other difficulties. It takes 200 draftsmen five weeks, for instance, to make all the working drawings for the steam-raising part of a power plant, and there are not enough trained draftsmen in Britain to do all the work that has been needed. The incredible industrial expansion of the last three years has called for draftsmen to design more ships than have ever been built before in British yards, new types of automobiles, railroad locomotives, aircraft, new industrial plants and machinery of all kinds. The demand for draughtsmen exceeds the supply, but this problem has stimulated the harassed industrialists, local educational authorities and the Government into providing training courses for bright young men and girls who are joining the ranks of skilled draftsmen in increasing numbers.

Training Young Craftsmen

The builders of the power plants, and the makers of the equipment that goes into them, are also handicapped by a shortage of skilled craftsmen. There are more craftsmen in Britain's engineering industries today than ever before, but there are still not enough, and the manufacturers want higher degrees of skill than they have known previously. So they have faced up to this problem, too, and in every engineering plant in Britain there are now lecture rooms, demonstration rooms and laboratories for the technical training of apprentices. It is compulsory training, and it is not confined to the manufacturers' classrooms; most apprentices also attend special courses at the nearest technical college or university. Out of adversities and difficulties there has quickly grown up a new system of part-time technical education in which the established education authorities, the industrialists and trade unions cooperate to turn young workers into highly skilled craftsmen. The full benefits will not be reaped immediately, for training takes time and almost every young man, when he is trained, has to go into military service for 18 months, but it looks as though in a few years British industry will have the world's best-trained craftsmen.

There is, however, another very difficult problem which will take longer to solve. It is the problem of placing unskilled workers in the most important jobs, and getting them to stay. The makers of power-station equipment, for instance, are located mainly in the English Midlands, where there are more jobs available than there are workers to fill them. One result of this is that unskilled workers move around from job to job and plant to plant with remarkable rapidity. It is not unusual for a manufacturer to lose all of his unskilled workers in the course of a year. With the help of Britain's Ministry of Labor—which provides living allowances to transferred workers — manufacturers in the English Midlands have been recruiting unskilled workers from other parts of the country where there is a little unemployment, but few of them stay for more than a few weeks because they cannot get houses of their own, and therefore, cannot bring their wives and children with them. So they return to their homes. This problem will not be solved until Britain can add con-

(Continued on page 86)

Basic Power Plant FIGURING

A Review for Old-Timers—A Must for Young-Timers

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By WILLIAM H. ENGELMAN,

Mechanical Engineer,
Department of Water & Light,
City of Cleveland, Ohio

NOW YOU'RE going to see why we published the tables of physical characteristics of Schedule 40 and Schedule 80 pipe in the August and September issues.

As we told you, such information is needed in solving practical problems in flow in pipes. If you did not save Tables A and B, Data on Schedule 40 and Schedule 80 pipe, write the Editors for tear sheets. We'll gladly send them as long as the supply holds out. Now here is Mr. Engelman's data sheet, at right.

BRITAIN'S INDUSTRIAL POWER

(Continued from page 85)

siderably to the 750,000 new dwelling units that have been built since the end of World War II; and as, in the last three years, she has built more new homes—in proportion to population—than any other country, it looks as though it will take another five years to solve the housing problem for transferred workers.

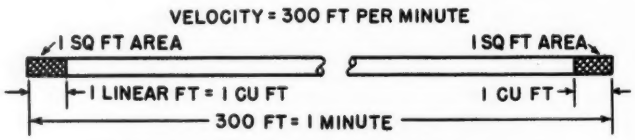
These problems—housing, the high labor turnover, the training of draughtsmen and skilled craftsmen—and the shortages of steel and other materials have all affected the building of new power plants, but they have also stimulated the manufacturers to search for new ideas. Under the stimulus of such difficulties as these, much British industry is showing remarkable enterprise. Two of the largest makers of turbines, dynamos and other gear for power plants, for instance, have solved the shortage of labor in foundries by making much of their equipment, not from castings, but from forgings welded together, and they have found that their new methods of fabricating generating sets from welded parts actually saves metal.

Taking all these difficulties into consideration, to build a modern power plant in three years is really quick building, and shows that plenty of enterprise has been used to overcome the obstacles. At this rate of progress, Britain's output of electric power will begin to draw level with the ever-increasing demand for it in 1952; and it is hoped that by 1955 she will have all the electric power that industrialists, farmers and housewives can possibly use.

Flow in Pipes Based on Area and Velocity.

Refer to Table A, Data on Schedule 40 Pipe, August issue and Table B, Data on Schedule 80 Pipe, September issue.

Assume a pipe of 1 sq ft cross-sectional area carrying water at a velocity of 300 fpm. Volume per linear foot is 1 cu. ft.
Volume per min. is 300 × 1 is 300 cu ft or 2,244 gal. water per min.



How much water will a 6 in. Sched. 40 Pipe deliver at a vel. of 300 fpm?
From pipe data sheet: Area is 0.2006 sq ft;
Volume per linear foot is 0.2006 cu ft;
Volume per min. is 300 × 0.2006 = 60.18 cu ft or 450 gallons.

How much water will a 4 in. Sched. 40 pipe deliver at a velocity of 200 fpm?
Area is 0.0884 sq ft; Volume per ft is 0.0884 cu ft.
Volume per min. is 200 × 0.0884 = 17.68 cu ft or 132.25 gal.

How much water will a 10 in. Sched. 80 pipe deliver with the water flowing at a velocity of 350 fpm?
Area is 0.4989 sq ft; Volume per ft is 0.4989 cu ft.
Volume per min. is 350 × 0.4989 = 174.62 cu ft or 1,306.16 gal.

How many pounds of saturated steam at 200 psia will a 12 in. Sched. 40 pipe deliver at a velocity of 10,000 fpm?
Area is 0.7773 sq ft; Total volume is 0.7773 × 10,000 = 7,773 cu ft.
From steam table: 1 lb of steam at 200 psia contains 2.288 cu ft.
Steam delivered is 7,773/2.288 = 3,397.3 lb per min.

The size of a steam pipe, based on an allowable velocity, can be found by the equation:

$$A\,V = 144\,W\,v_g$$

Let:
A is Area of pipe, in square inches. (From pipe data sheets.)
V is Velocity of steam in feet per minute.
W is Weight of steam flowing in pounds per minute.
v_g is Specific volume of steam at psia in cubic feet per lb.

$$A = \frac{144\,W\,v_g}{V}; \qquad V = \frac{144\,W\,v_g}{A}; \qquad W = \frac{A\,V}{144\,v_g};$$

Find area of pipe in square inches required to deliver 4,200 lb of saturated steam per hour at 44 psia. Assume a velocity of 5000 fpm.

$$A = \frac{144 \times 4{,}200 \times 9.601}{60 \times 5{,}000} = 19.373 \text{ sq in.}$$

Use 5 in. Sched. 40 pipe; Area is 20.006 sq in. or 0.1390 sq ft.

A 5 in. Sched. 80 pipe delivers 36,000 lb of saturated steam per hour at 390 psia. What is the required velocity in fpm?

In solving this problem use area in sq in. and area in sq ft. (Table.)

$$V = \frac{144 \times 36{,}000 \times 1.191}{60 \times 18.19} = 5{,}660 \text{ fpm.} \qquad V = \frac{36{,}000 \times 1.191}{60 \times 0.1263} = 5{,}660 \text{ fpm.}$$

How many pounds of steam at 150 psia and 500 F will pass through a 12 in. Schedule 40 pipe, if the velocity is 10,000 fpm?—a. In one minute? b. In one hour?

a.) $W = \frac{111.93 \times 10\,000}{144 \times 3.681} = 2{,}112$ lb per min.

b.) $W = 2{,}112 \times 60 = 126{,}720$ lb per hour.

Solving the last problem individually, the solution is as follows:
Volume at 150 psia and 500 F = 3.681 cu ft per lb.
Area of 12 in. pipe (11.938 in. I.D.) is 111.93 sq in. or 0.7773 sq ft.
Steam delivered is 10,000 × 0.7773 = 7,773 cu ft per min.
and 7,773/3.681 = 2,112 lb per min. or 126,720 lb per hour.

Steam Pipe Sizing Based on an Allowable Velocity.

Example: Five 1,000 hp boilers are operating at 200 per cent rating, the steam pressure is 300 psia and the temperature 600 F. Find size of header to carry the steam at a velocity of 9,000 fpm.

Solution: $5 \times 1{,}000 \times 2 \times 34.5 = 345{,}000$ lb per hr. or 5,750 lb per min.
v_g at 300 lb and 600 F is 2.005 cu ft per lb (from steam table).

$$A = \frac{144 \times 5{,}750 \times 2.005}{9{,}000} = 184.5 \text{ sq in. or } D^2 \times 0.7854$$

$D = \sqrt{184.5/0.7854} = 15.32$ in.; use 16 in. Sched. 40 pipe, 15.0 in., I.D.
Max. allow. press. at 650 F is 448 psi (see pipe data sheet).
Calculating the velocity from the diameter found,

$$V = \frac{144 \times W \times v_g}{A} = \frac{144 \times 5{,}750 \times 2.005}{176.7} = 9{,}395 \text{ fpm vel.}$$

The 16 in. header, Sched. 40 pipe, is ample in area and in strength.

Example: A main steam header forming a complete loop is supplied by five boilers of different capacities. The steam pressure is 200 psia and the steam temperature 600 F. The supply is as follows:

Boiler No. 1 has a 4 in pipe with a steam velocity of 4,000 fpm.
Boiler No. 2 has a 5 in pipe with a steam velocity of 5,000 fpm.
Boiler No. 3 has a 6 in pipe with a steam velocity of 6,000 fpm.
Boiler No. 4 has a 8 in pipe with a steam velocity of 8,000 fpm.
Boiler No. 5 has a 10 in pipe with a steam velocity of 10,000 fpm.

Note: Velocity of steam is 1,000 fpm per inch of pipe diameter.

How many lbs of steam are carried to the main header and what is its size if the allowable velocity is 1,000 fpm per inch of dia?

Solution:
4 in pipe at 0.0884 cu ft per ft = 4,000 × 0.0884 is 353.6 cu ft.
5 in pipe at 0.1389 cu ft per ft = 5,000 × 0.1389 is 694.5 cu ft.
6 in pipe at 0.2006 cu ft per ft = 6,000 × 0.2006 is 1203.6 cu ft.
8 in pipe at 0.3474 cu ft per ft = 8,000 × 0.3474 is 2779.2 cu ft.
10 in pipe at 0.5476 cu ft per ft = 10,000 × 0.5476 is 5476.0 cu ft.

Total volume of steam delivered to header = 10,507.0 cu ft per min

Assume a 14 in. O.D. pipe at 0.9397 cu ft per ft. (From Table A Col. 7) which will give a velocity of 10,507/0.9397 = 11,180 fpm.
and
10,507/3.06 = 3,434 lb of steam per minute,
= 206,040 lb per hr (3.06 from steam table)

Boiler No.	1	2	3	4	5
Sched. 40 pipe, in.	4	5	6	8	10
Vol. cu ft/ft.	0.0884	0.1389	0.2006	0.3474	0.5476
Steam Vel. fpm.	4000	5000	6000	8000	10,000
Steam, cu ft/min.	353.6	694.5	1203.6	2779.2	5476
Steam, lb/min.	115.6	227.1	393.4	908.3	1789.6

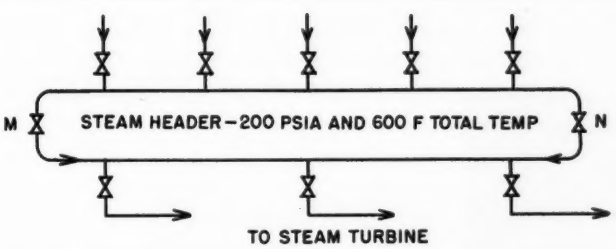
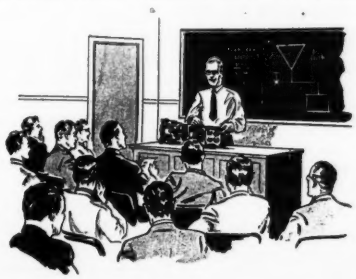


Fig. 2. Sketch to steam header Problems, Sheet No. 4, supplied by 5 boilers



PRESSURE REDUCING

I HAVE JUST received the July issue of POWER GENERATION which I enjoy reading very much. However, I believe that in the Basic Power Plant Figuring article beginning on page 60 a slightly misleading statement occurs in the first sentence of the second paragraph.

The statement is true for pressures below 450 psia; but in many plants today, 450 psia is not considered high pressure. Perhaps if the author would include an example of 1200 psia dry and saturated steam expanding to the right over into the wet region of the Mollier chart, the picture would be more complete.

Boston, Mass. HAROLD E. STICKLE

▶ Mr. Stickle is absolutely right of course and we should have made the statement read: "For pressures below 450 psia, dry saturated steam produces superheated steam at the lower pressures . . . "

It certainly is true that, in the overall power plant picture today, 450 psia is not high pressure. To the utility engineer in the 1250-psi and 900-psi plant it is low pressure. But it must be remembered that to many men in industrial power plants, 450 psi is still high pressure, for there are still only a relatively small number of 450 and 600 psi industrial power plants and only a handful of 1250 psi industrial power plants.

In this Basic Power Plant Figuring data, taken from a course given to power plant apprentices, the author finds most of them in plants where the pressure is well below 450 psi, hence it is natural for him to think primarily of such conditions. In editing the material we obviously fell into the same pattern of thought, which does not go quite far enough.

If you look on the full size Mollier Chart in Keenan & Keyes steam tables, you see that the saturation line drops to the left for all pressures above 450 psia. Hence, for many of the higher pressures saturated steam expanding through a reducing valve at constant enthalpy may result in final steam conditions almost all in the wet region. for example:

Initial	Final
1250 psia	600 psia
582.4 F (sat. temp.)	572.4 F—
1178 Btu per lb	3½% moisture
	1178 Btu

Of course, in most practical cases, steam at pressures of 900 or 1250 psia is seldom dry and saturated when it enters the valve and usually expands to a condition still superheated, although there can be exceptions here, depending on initial and final conditions.

However, to make everything perfectly clear, we shall present, as soon as possible, some typical examples of high-pressure reduction, plotted on the Mollier Chart, to show the variations from the general statement made. These should be mentioned in case the question comes up in examinations.

PACKAGE SUBSTATIONS

Investment in electrical distribution systems . . . The Package Sub-station—What it is, and why it is important . . . Savings in time effected by the use of the package sub-station . . . Savings in cost . . . Flexibility of design

By V. A. RYDBECK
Power Transmission and Distribution Division
General Electric Company, Schenectady, N. Y.

DISTRIBUTION is generally known to be the largest single element in electric utility plant investment. It has been frequently spoken of as anything from a third to one half of the total depending on the source of the speaker's information. "Statistics of Electric Utilities in the United States," published by the Federal Power Commission gives the national average investment in distribution as approximately 41 per cent. Transmission represents 15 per cent of the total system investment, production only 38 per cent, and general and intangible elements approximately 6 per cent.

The package substation now makes it possible to reduce this high investment in distribution by eliminating costly piece-by-piece design, ordering and installation of substations.

The package substation consists briefly of one or more unit substations with their pre-fabricated incoming steel structure. It includes such material as:

Strain Insulators
Group Operated Switches
Hook Switches
Lightning Arresters
Fuses
Outdoor Oil Circuit Breakers
Control Cable (within station)
Wiring Diagrams
Foundation Plan Drawings
Bus Supports
Copper Buses
Grounding Material
Mounting Bolts
Steel Structure per NEMA
Power Switching Equipment
Standards No. 45-94
Luminaires
Steel Erection Drawings

The simplified ordering of a complex bill of material is in itself a unique advantage. However one of the outstanding advantages of the package substation is the use which it makes of factory pre-assembled items. In the factory under ideal conditions and on a production basis pre-assembly can be made in a fraction of the time and at a fraction of cost of the same work done in the field where adverse weather conditions and untrained help often prevail.

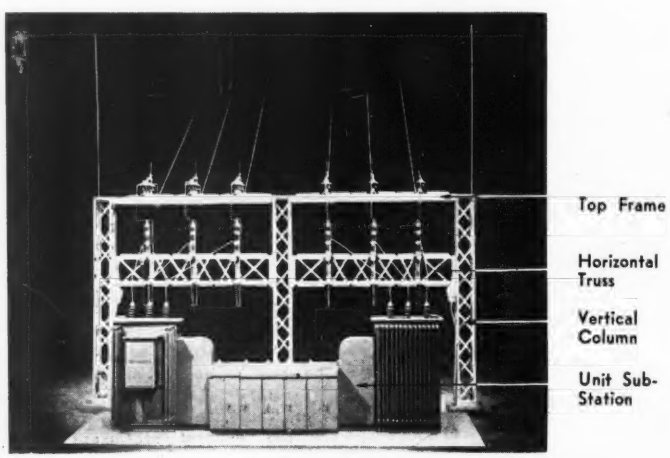


Fig. 1. Basic elements of the package sub-station

Each package substation is especially designed for ease of assembly with standard factory pre-assembled component parts. One of the principal members of the structure is the two foot square latticed column. Provision is made at the base of each column for bolting it to the foundation piers. Factory fabricated trusses mounting standard apparatus are drilled and arranged for assembly between two or more columns thirty inches below a standard top frame (See Fig. 1). With the latticed columns as the basic element and with standard top frames and trusses, any number of a wide variety of different types of structures can be assembled and provision included for alteration to meet future load growth and re-arrangement.

The steel structure is shipped to the substation site with the columns, top frames, and trusses pre-fabricated and ready for assembly. Arrangement and erection drawings, mounting and foundation bolts are included. All that the purchaser is required to furnish is the problem, the concrete mounting pad or platform, and the incoming power line. Whether power requirements are large or small, the new package substation as contrasted to the conventional piece-by-piece ordered and installed substation, offers three features.

The first feature of the Package Substation is *saving in time* as shown in Table I.

Three months design and layout time are accomplished in one hour with standardized package substation designs built around a standard column, horizontal truss, and top frame. Now, instead of detailing and engineering each nut and bolt, specifying the size, thread, and quantity; instead of making many calculations and referring to many pages in the

WATER PROBLEMS

Always Vary

Water is the most common and widely used raw material. Its use can . . . and usually does . . . pose an infinite variety of problems. These problems are never identical. Variables will include the water itself, the plant equipment, the operating conditions and many other factors. The proper approach to the solution of a water treatment problem . . . whatever its nature . . . is to engage the service of specialists who provide an adequate and well-balanced program of scientific control.

W. H. & L. D. BETZ is an organization of engineers and chemists specializing in the solution of all industrial water conditioning problems including boiler feedwater . . . cooling water . . . air conditioning . . . industrial waste treatment. Years of experience have made Betz water conditioning service scientifically correct . . . complete . . . economical. Whatever your particular water conditioning requirements, our staff of engineers is ready to serve you. W. H. & L. D. BETZ, Gillingham and Worth Streets, Philadelphia 24, Pa.
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Table I

SAVINGS IN TIME — 29 Per Cent

	Conventional Substations	Package Substations
Design & Layout Time	3 Months	—
Manufacturing Time	20 Months	18 Months
Installation Time	3 Months	½ Months
	26 Months	18½ Months
Total Savings		7½ Months

handbook for the thickness, drillings, and finish of the structural steel, a simple one line diagram or a brief drescription of the functions which the substation is to perform, is all that is required to order a package substation.

The number and type of functions which the substation is to perform usually determines the number of structural elements and in general the substation arrangement. Several of the more simple and standard substation arrangements have been classified, set up on a model basis, and then photographed. Thus in many cases photographs are available, enabling prospective purchasers to see exactly what their package substation will look like, even before they place an order.

Manufacturing time of these package substations is also reduced since component parts are either stocked or can be manufactured repetitively in factories already tooled and experienced in this production.

Installation time is greatly reduced since the package substation arrives in factory pre-assembled sections which are usually as large as shipping and handling facilities permit. Pre-fabricated columns, top-frames, and trusses are ready for assembly. Arrangement drawings, erection drawings, mounting and foundation bolts, and connection diagrams are all furnished. In fact, everything is included for an immediate "on the spot" installation.

When shipment is not made as a complete unit, shipments are co-ordinated by the factory so that plans and preliminary installation work can be started early, and not prolonged by lacking details and parts. By eliminating installation bottlenecks, the factory co-ordination helps to assure a sizable saving in installation time.

Purchasers of package substations should therefore achieve an overall saving in time of seven and one-half months over piece-by-piece substation planning purchases. This saving in time has proven to be a most important feature in assisting power companies and factories to meet their usually heavy postwar demands. In several instances this has meant that power was available when it was needed to start operation of new factories and supply new residential suburbs. This power would not have been available when required for factory operation or residential loading if piece-by-piece planning and purchasing of a conventional substation were employed.

A second feature of the Package Substation is *the saving in purchasing costs* as shown in Table II.

The cost of designing and laying out a package substation is only a small fraction of that normally spent in laying out, designing, and ordering the piece-meal substation. In Fig. 2, it was pointed out that the normal three month design and layout time for the piece-meal substation would be reduced to only one hour for the packaged substation. In a few cases this has meant that already overloaded engineering staffs did not have to be expanded and additional office space did not have to be provided. Unless accounting systems are arranged to change engineering and drafting time to the new substation project this saving often goes un-heeded. This saving usually amounts to several per cent of total substation installed cost and occurs directly to the purchaser.

Repetitive manufacture of standard components will inevitably give a superior substation at reduced manufacturing cost. The original always costs considerably more than the reproduction. To bring out a new model car cost the automotive manufacturer somewhere in the vicinity of one million dollars. This high first cost of tooling and design is not borne by the purchaser of the first automobile but is shared alike by the many purchasers of that model of automobile thus giving every owner the latest and most modern motoring equipment at the lowest possible cost. Repetitive manufacture of standard substation designs, means that substation purchasers will receive a superior equipment and have cash in their pocket too.

The package substation is installed easily and economically because it is shipped in factory pre-assembled sections and because these shipments are coordinated. This permits a very decided saving in complete substation installed costs.

Purchasers of the package substation should therefore realize a saving in complete substation installed costs of at least 23 per cent over piece-meal conventional substation purchases. With every indication pointing to a closer business margin of profit, industries should not overlook the important savings which a package substation offers them.

Table II

SAVINGS IN COST — 23 Per Cent

	Conventional Substations Per Cent	Package Substations Per Cent
Installation & Layout Cost	5	—
Manufacturing Cost	80	75
Installation Cost	15	2
	100	77
Total Savings		23

A third and outstanding feature of the package substation is *flexibility of design* as indicated in Fig .2.

The availability of these package substations with their many combinations and their flexibility for additions or changes, makes it a natural

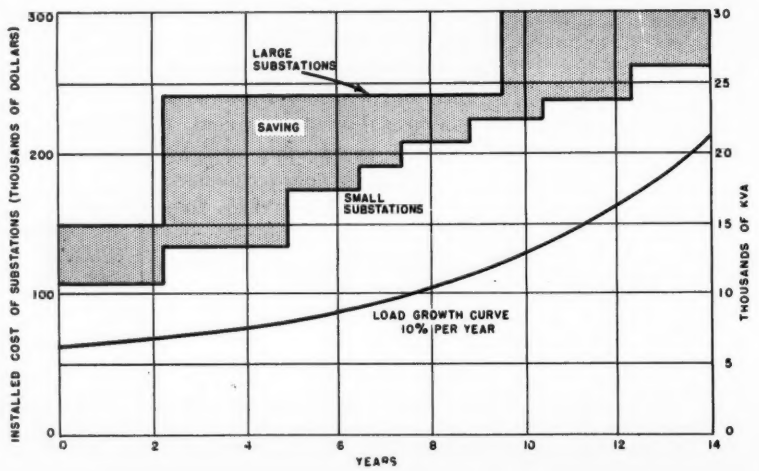
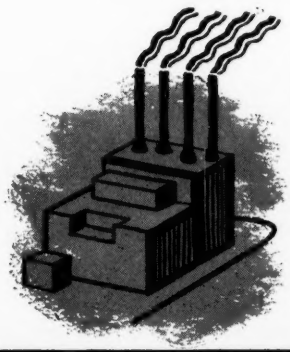


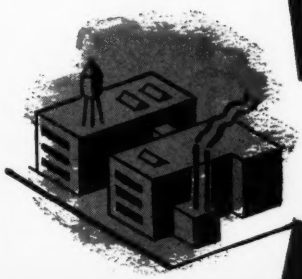
Fig. 2. Comparison of costs of small and large sub-stations showing the flexibility of the design of the package sub-station

FOR EVERY INDUSTRY...

WICKES

2-DRUM STEAM GENERATORS





The two engineers's drawings shown here are typical of the Wickes two-drum steam generators being installed in industries and public buildings of all kinds. Wickes Boilers are operating at an extremely high degree of efficiency and owners' records show very modest maintenance costs. Capacities of Wickes Boilers are up to 250,000 lb. steam per hour, pressures up to 850 psi. All types of multiple drum boilers, adaptable to any type firing. Contact your nearest Wickes representative or write our engineers in Saginaw.

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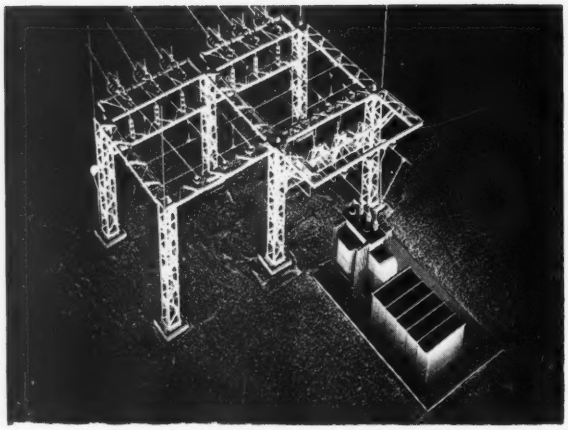


Fig. 3. This view (1948) showing a model of an initial installation of a package sub-station, together with the views of its subsequent growth in Figs. 4 and 5 show the flexibility of this method of construction

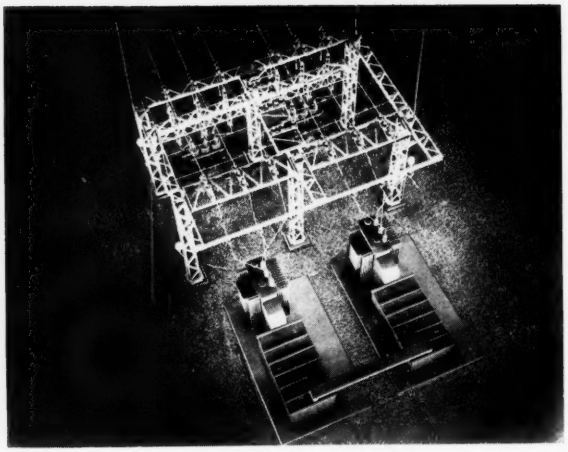


Fig. 4. Here, in 1952, the initial installation (shown in Fig. 3) has been doubled

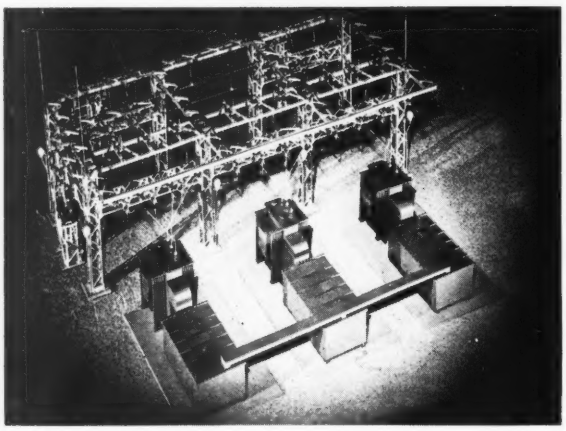


Fig. 5. This shows the addition of a third unit in 1955

for what is commonly known as the Building Block Approach to Substation Design. More and more substations are being built with this approach in which a single substation is first installed, for initial small loading. As the load grows, an additional unit can be added. Should the load still continue to increase, a third unit can be added to the substation. If on the other hand the anticipated load growth does not take place or if present loading is reduced, units can easily be removed to other locations since both large and small substations are made up of the same basic units.

Thus it is possible for the system planner to have his substation capacity follow much more closely the load growth curve for the area being served and it helps him insure against excessive unused capacity. For example, instead of building a large 15,000 kva substation costing $150,000 to supply his present 6,000 kva load, and having to increase it to a 24,000 kva substation costing $240,000 inside of two years, the Building Block aproach permits growth in small units. This is shown in Fig. 2 by the line entitled "Small Substations."

Thus, instead of having money invested in large amounts of unused substation capacity which is depreciating in value, purchasers of package substations are able to invest this money elsewhere at guaranteed dividends. This means that in addition to previously mentioned initial savings of 23 per cent, the flexibility of package substations making possible a Building Block approach, allows additional sizable future savings.

Three features of package substations are (1) Saving in Time (2) Saving in Cost (3) Flexibility of Design. To stockholders these advantages mean greater stock dividends. To utility managers, these advantages mean better customer goodwill, increased profit on fixed rates, and a superior system. To the everyday user of electricity, these advantages of package substations mean power when it is needed, at present low or even reduced power rates, and at better voltage conditions.

FAN GUARANTEES

(Continued from page 65)

manufacturer cannot indiscriminately guarantee *installed* fan performance and why reliable fan manufacturers incorporate the following Code excerpt in their proposals to customers:

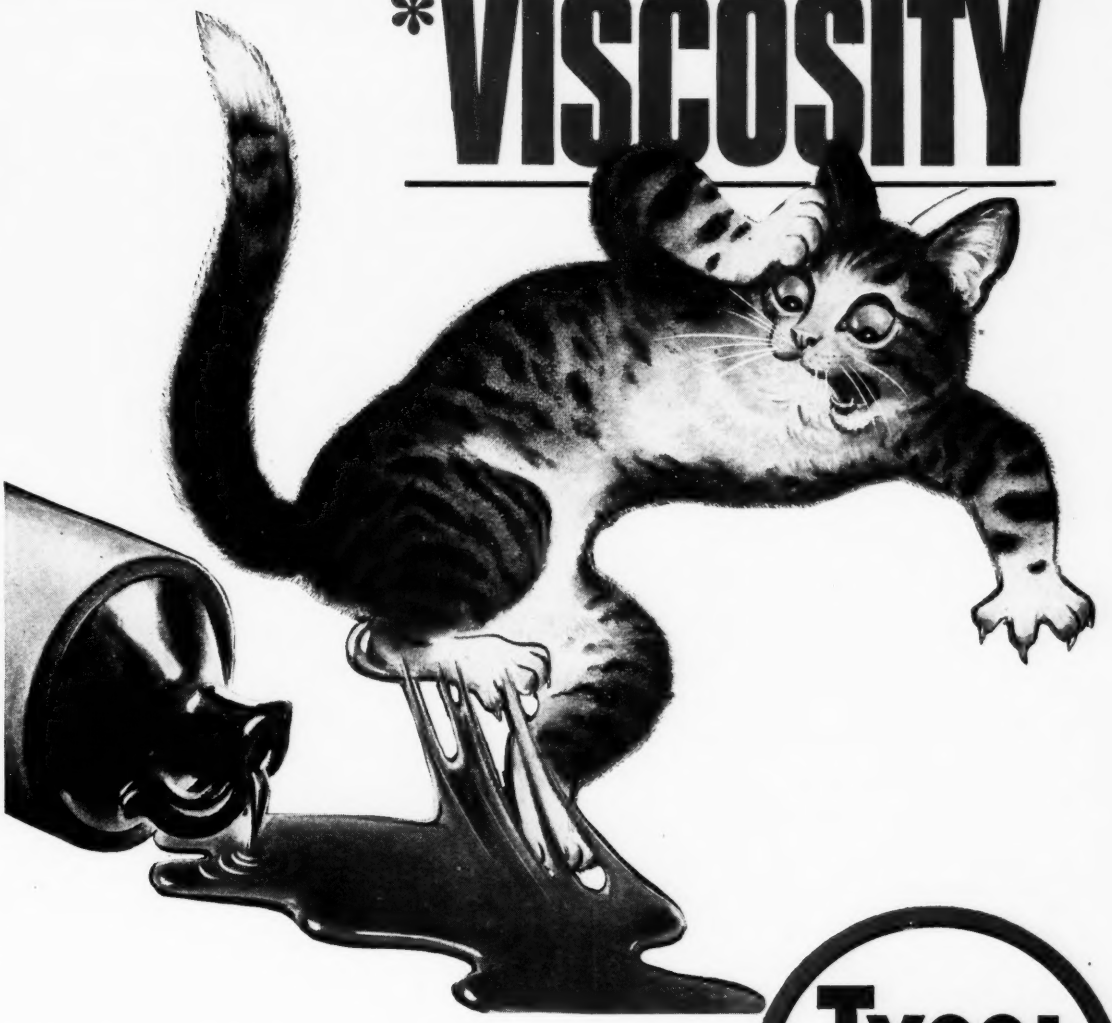
"**Field Test of Fans:**—Research undertaken by Members of the Association in Cooperation with Test Code Committees of the Engineering Societies reveals thus far that no accurate or practical method of testing fans in the field has been developed by means of gas analysis or by use of the Pitot tube.

"Since the values obtained from field tests vary so widely from actual results, guarantees of the performance of fans can only be made from laboratory tests conducted by the manufacturer in accordance with the 'Standard Test Code for Centrifugal and Axial Fans' approved jointly by the National Association of Fan Manufacturers and the American Society of Mechanical Engineers.

"In accordance with Paragraph 17, Bulletin No. 103 of the 'Standard Test Code for Centrifugal and Axial Fans' the performance of fans with wheels larger than 35 in. in diameter may be calculated from tests made on fans of the same design and similar proportions having a wheel not less than 35 in. in diameter. For fans having wheels less than 35 in. in diameter, the performance may be calculated from tests made on fans of the same design and similar proportions and having a wheel diameter not greater than the rated size. The manufacturer reserves the right in all cases to test proportional fans as outlined in this paragraph."

AN AMAZING and little known characteristic of frozen mercury is its cohesive force. When two pieces of frozen mercury are brought together, they are instantaneously bonded and become one piece which then cannot be separated without destroying it.

*VISCOSITY



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The Trouble With Engineers

Oscar, the Gas Work's Owl Scratches a pithy comment on engineers' weaknesses which in the long run not only solves a deep mystery but leads to the recovery of the corpus delicti

By JOHN RAVEN

THE DAY STARTED WRONG. First I overslept, then as I sneaked in past the Boss' office I knew he was mad because I heard him bellowing thusly:

"Stop that bawling, will you? Confound it, we'll find your husband if you give us a chance."

While I was still wondering whose husband we had to find, the morning breeze flipped a paper on my drawing board and I glimpsed the hen-scratchings that invariably mean I'm in trouble.

greetings (said the scratchings) from a birds i view 2 many of u njuneers r jumping at cnclusions b4 u get th fax 4 instans u think ur tanks r safe but all their tops r so rotten they cant hold a cat ysterday afternoon late i saw a life snufd out in the amonya tank when th roof broke thru n that dumb maintenans man u call pinball jackson watched the gage bounce up n down n cncluded it didnt mean anything now u bettr get th body out of th tank b4 it plugs th pumps also u bettr fix all ur tanks b4 sombody real important gets drownd ur frend oscar th gas wrks oul hoo sees all n nos all

I tore up the note since Oscar is my secret, and grabbed my hat. I had to get to that ammonia tank in a hurry, for if the Boss heard about it before I could give him the facts, my name would be dirty black mud, and he would make me join the unemployed besides.

I headed for the door but the Boss, 200 pounds of him with three red and projecting chins, got there first. He waved a paper under my nose.

The Boss, 200 pounds of him, got there first

"Who are you, anyway," he bellowed, "Simon Legree? Here's a man called A. Moon writes me a note saying he wanted to see a doctor yesterday and you wouldn't let him off. If he dies, he says it's your fault, and he's going to haunt the gas works. Do you know what's going to happen with a ghost running around here?"

"Easy Boss," I said with remarkable self-control in the circumstances. "A. Moon didn't want a doctor. He wanted a drink, a lot of drinks. He goes off on bats, I know him, and he's not going to die and haunt anybody."

"Now you're jumping at conclusions," shouted the Boss from deep among his three chins, "because A. Moon is missing. He's been missing since late yesterday afternoon. Right now his wife is bawling like Niagara Falls all over my office. She's accusing me of letting something happen to him. She's demanding the body. So, I ask you, if A. Moon is not dead, where is he?"

I said I didn't know and he stuck a finger into my chest like the end of a slice bar.

"Don't you know the first guy who thinks he sees A. Moon's ghost will scare half the plant out of a week's work? Either you find A. Moon and quick or we'll get a new engineer. Understand?"

Obviously this was no time to argue with a guy like the Boss, so I said "Yes sir," very meekly and he let me past.

I didn't walk to the ammonia tank, I ran. The thing had a wooden cone-like roof, and it looked all right except for a small splintered hole alongside the hatch. The float gage on the outside of the tank stood at the full level; I wondered if somebody's poor dead hand still clutched the inside rope, deep beneath the deadly liquor.

There was no sign of Pinball Jackson in the maintenance shop directly across the road from the tank. His people guessed he was out on a job. They also guessed somebody had borrowed the grappling irons because they couldn't find them. They knew nothing for sure and guessed everything.

"From now on," I told them angrily, "I want facts from people in my department, not guesses. It's going to be facts, or else. Somebody's dead right now, because a certain guy in my department was too lazy to do anything but guess."

I called the fire department.

"Boy!" exclaimed the Chief. "So that's where A. Moon is. His ghost already has fouled up our new pumper,—it won't start."

"I didn't say A. Moon is in the tank," I shouted. "Stop jumping at conclusions." But the Chief didn't hear me, he'd hung up.

I laid down the phone and discovered Pinball Jackson had been listening on the extension at the next desk.

"Jeez!" said Pinball looking pale. "I knew something would happen

Saw the firemen lifting a small figure through the hatch

the minute I saw that black cat yesterday. John, this place ain't safe with A. Moon's ghost runnin' around raisin' sand. I think I'll quit."

"Quit!" I shouted. "You're fired! Your laziness caused this whole mess. And stop talking about ghosts. There's no such thing as a ghost."

"There is in the gas works," said Pinball flatly. "What d'you think a black cat is, a angel? Especially on the ammonia tank."

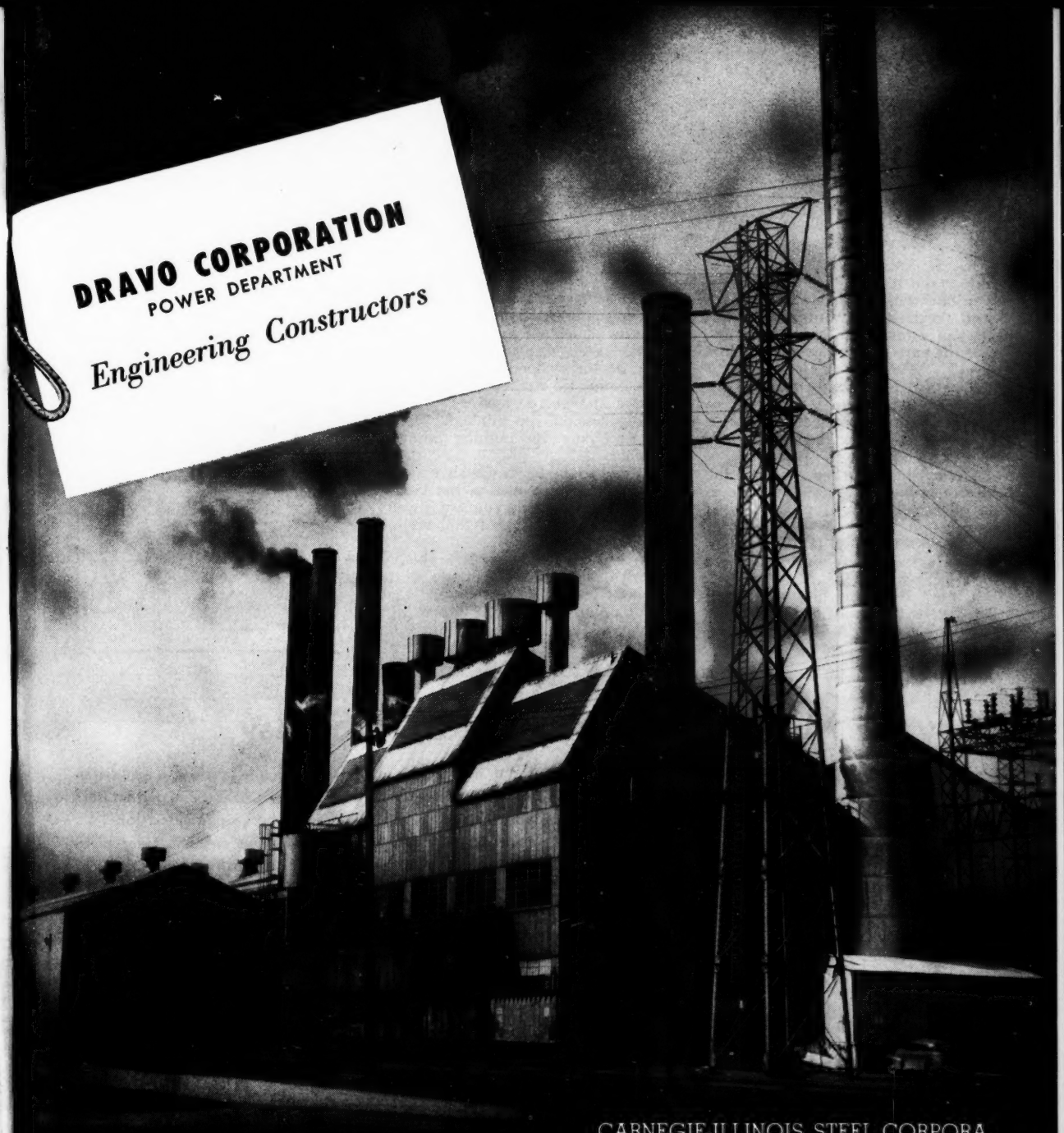
The ladder truck and hose cart came up in a cloud of dust and ringing bells. The Chief jumped off the cart and yelled heartily:

"Don't worry John. We'll get A. Moon out. Dead or alive."

They ran a ladder up to the tank, put on their ammonia masks, and dropped their grappling irons through the hatch.

Then the works ambulance came squawking through the crowd, making more noise than speed, as usual. The doctor jumped out and shoved his face against my ear.

"Don't tell who tipped you off," he whispered, his breath full of onions, "but I hear A. Moon's widow plans to sue you for manslaughter. And for Pete's sake why didn't you make



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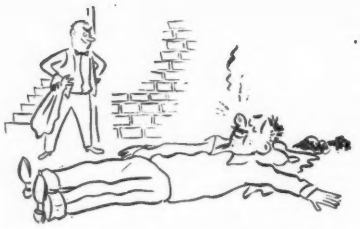


. . . seen him sleepin' off a drunk

him go outside the gate to die? This way half the works thinks it's stuck with his ghost and wants to go home. Do you want me to carry him outside the gate before I pronounce him dead?"

I wanted him mostly to mind his business, but before I could say so one of the maintenance men yelled I should come to the phone. Of course it had to be the Boss.

"John," he bellowed, "what's the idea of hiding A. Moon out there in an oil tank? Bring him in here at once."

"He's not in an oil tank," I yelled back. "I haven't found him. Give me time, will you?"

"Time!" the snort drove me back two feet to save my ear drum. "If you don't produce A. Moon in fifteen minutes you can draw your money or marry his widow. You hear? She's driving me crazy."

He hung up. I went back to the ammonia tank wondering what he'd say when maybe the guy in the tank dumped another widow on his hands. Ask me to commit bigamy, I guess.

I saw the firemen hauling something out of the tank. Carefully they lifted a small figure through the hatch. I was shocked at the size: I never dreamed ammonia could destroy a body so fast.

Carefully the dripping burden was lowered to the ground. A gasp went up from the crowd sounding like the works whistle with a frog in its throat.

The doctor stooped and peered at the remains. He rubbed a hand over his eyes and peered again.

"Holy smoke!" he blinked. "This isn't A. Moon. It's nothing but an old black cat!"

I turned to the Chief. He shrugged.

"There's nothing else in the tank, John. Whatever made you say it was A. Moon? You've upset the whole works."

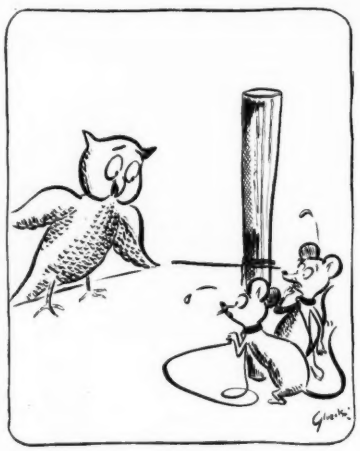
The crowd laughed. Everybody was in a good humor but me, and somebody feeling witty shouted:

"Hey John, if you want to present that cat to A. Moon I seen him ten minutes ago sleepin' off a drunk in the cellar of purifier house number 3."

We're repairing all the tank tops now, but until the work is finished there is a sign on each tank which reads thusly:

WARNING: KEEP OFF THE TOP OF THIS TANK. IT WON'T HOLD A CAT.

When Oscar said a cat, he meant a cat, and I don't want people jumping at any other conclusion.



Why the Maintenance Man is Bitter on Sunday

By L. BOYD McINTIRE

Everybody's against him, he feels . . . Nobody loves him . . . But if you listen to his gripes, you can keep maintenance costs down . . . Some manufacturers fail to design equipment so it can be repaired; others do a good job . . . Instruction books should give details learned by the service men, clear blueprints, notes of changes . . . If maintenance man gets instructions for wrong model, can't get parts, serial number or nameplates don't give proper identification, his exasperation backfires on manufacturer . . . Designers should consider space for repair work, headroom, good light and proper tools . . . Train your maintenance men properly; don't use skilled men for unskilled work

IT IS GRATIFYING to find so many articles in the technical magazines about maintenance. They serve a most useful purpose, supplying ideas and methods that aid the man actually doing the work.

A maintenance man's life is a hard one. Every man's hand is seemingly turned against him to make his life miserable. Equipment manufacturers, installers, buyers and operators all go their merry ways, apparently unaware that all machinery will some day require repair. Recognition of that fact, with a resultant cooperation between all the parties involved, would go a long way toward making maintenance a lot easier, create more good will and good feeling all along the line, and most important of all, decrease maintenance costs greatly.

Fig. 1. . . . what good are these instructions with machine prints so small you can't read them

The reason for my apparent bitterness toward all mankind connected with power plant equipment is that I have spent the last three days repairing a superheater in a 363 hp water tube boiler, trying to work in a spot that a self-respecting rat wouldn't crawl into to escape the world's most ferocious cat. In the process, I picked up black and blue marks all over my body.

Design Equipment So It Can Be Repaired

Manufacturers have a definite responsibility to design equipment so that it is readily repaired. Some of them do a great job in this respect, and their equipment is a joy to work on. Others design so poorly that I wonder sometimes how they get the stuff assembled in their shops with all the special tools they undoubtedly have. It is a black mark against a manufacturer when a maintenance man finishes a difficult repair job and invariably remarks "If the so and so's that built this junk had to repair it, they'd build it different."

Citing an example, pump bearings should be readily accessible for cleaning and replacement. Some are and some definitely are not. In a couple of pumps we have in the plant, a simple change in the dowelling arrangement of the outboard ball bearing case would enable the bearing to be replaced without lifting out the impeller.

The manufacturer supplies a vast amount of headaches for maintenance workers in the incredibly poor instructions and parts lists put out in far too many cases. Some such parts lists will cover a dozen or so different models, for some strange

BASIC LINES OF DEFENSE IN BOILER WATER CONDITIONING

THE FOURTH LINE OF DEFENSE IS BLOWDOWN ADJUSTMENT

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WATER ENGINEERING SERVICE

3/18/49.

Plant UN... Address ... Operator MASON BARNETT &

Report of Water Conditions

DATE	HOUR	BOILER WATER P	M	H	A (EX. ALK. M-P)	B (OH) 2P-M	C (CO3) A-B	BOILER NO.	AS Ca CO3 P	M	H	AS SODIUM CHLORIDE CL	PHOS-PHATE AS PO4 PPM	AS SODIUM SULFATE SO4	SULFATE RATIO	AS SODIUM SULFITE SO3 PPM	OXYGEN O2 CC PER L.	REMARKS ~~TREATMENT~~
3-9-49	10:00 AM	1.8	3.3	0.4	2.9	0.3	2.6	1	28.0	35.0	0.0	6.8	4.5	42.0	OK	80		
"	"	1.1	2.2	0.6	1.6	0.0	1.6	2	28.4	35.5	0.0	6.8	4.0	44.0	OK	70		
3-10-49	"	1.6	2.9	0.5	2.4	0.3	2.1	1	31.4	42.2	0.0	10.5	8.0	50.0	OK	15		INCREASE BLOWDOWN
"	"	1.6	3.2	0.5	2.7	0.0	2.7	2	21.2	28.4	0.0	6.0	4.5	35.0	OK	50		
3-11-49	"	1.8	3.4	0.7	2.7	0.2	2.5	1	24.2	32.4	0.0	6.0	3.0	41.0	OK	45		
"	"	1.6	2.8	0.7	2.1	0.4	1.7	2	32.4	40.8	0.0	6.8	5.5	53.0	OK	55		
3-12-49	"	1.9	3.1	0.4	2.7	0.7	2.0	1	25.2	35.0	0.0	5.6	3.5	44.0	OK	40		
"	"	1.9	3.1	0.6	2.5	0.7	1.8	2	26.0	33.4	0.0	6.4	4.0	41.0	OK	40		
3-13-49	"	1.8	3.4	0.6	2.8	0.2	2.6	1	30.0	28.0	0.0	5.2	3.5	37.0	OK	25		
"	"	1.6	2.9	0.5	2.4	0.3	2.1	2	25.6	36.0	0.0	5.6	3.0	40.0	OK	40		
3-14-49	"	1.8	3.2	0.7	2.5	0.4	2.1	1	17.4	24.8	0.0	3.6	1.0	31.0	OK	25		DECREASE BLOWDOWN
"	"	1.7	3.3	0.6	2.7	0.1	2.6	2	23.2	36.8	0.0	6.5	3.0	45.0	OK	45		
3-15-49	"	2.0	3.4	0.5	2.9	0.6	2.3	1	24.4	36.4	0.0	6.8	5.5	45.0	OK	25		
"	"	1.3	2.5	0.4	2.1	0.1	2.0	2	26.0	37.6	0.0	6.4	4.5	47.0	OK	40		
3-9-49	10:00 AM		(FEEDWATER)					—				0.6						

The production of good quality steam is one of the principal objects of steam plant operation. The deconcentration of dissolved and suspended solids must be regulated to avoid critical concentrations.

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2. Adjustment of internal treatment
3. Proper means for treatment application
4. Blowdown adjustment
5. Test control

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reason all different from the model you purchased.

One of the largest electrical manufacturers in the country puts out such lists covering so many similar models that it is practically impossible to order repairs from them. Some time ago, we needed some small contacts for one of their induction type time-delay overload relays. The complete nameplate reading was sent in along with the names of the parts required, taken from their so called parts list that came with the relay. The order was promptly returned with the usual "unable to identify required parts" letter.

After a couple of months of very interesting correspondence concerning these contacts, the manufacturer sent in one of their engineers to examine them. After a couple of hours of poring through a briefcase of data sheets and comparing them with the actual contacts, he came up with the bright statement that, if we would order the contacts by such and such a number, we might get what we wanted.

A running fight was carried on with this same company for a number of years about repair parts for some air conditioning units of their make. They finally came up with the prize answer that the units must have come equipped with the wrong nameplates.

Another recent and vivid reminder of manufacturer's incompetence concerns a 13.5 kva gasoline-driven emergency lighting generator about 3 years old. A print was desired of the coupling arrangement between the motor and generator, so the complete nameplate data was sent in to the manufacturer. An answer was received that they did not recognize the serial number. After the usual lengthy and involved correspondence, we were advised that the model in question had been discontinued, and that no records were available concerning it.

Give Maintenance Man Good Prints

A sore spot with maintenance men is the quality of the prints supplied, if at all. An otherwise good instruction book may have such a poor or small print that it is useless as a guide for repair work. When taking a machine apart for the first time a good print showing detail plainly is a big aid. The maintenance worker then knows just exactly what he is up against with a consequent saving in energy and time. And incidentally, an excellent print of a Model A, when you have a slightly different Model B, can help lead the repair man straight into the nut house.

Fig. 2. . . . the instruction book says "pin D is easily removed by gentle tapping"

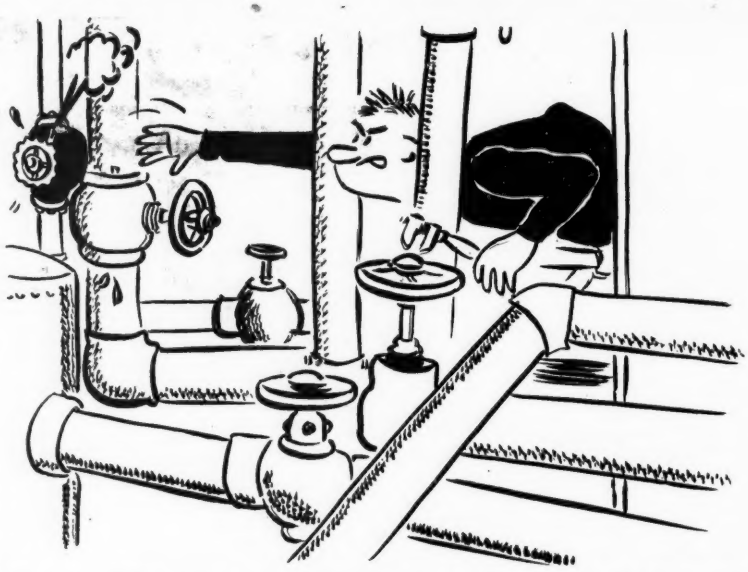


Fig. 3. . . . make sure a valve will be neglected, and fail when most needed, by locating it like this

Although instruction books are steadily improving, some being excellent, there is still a vast room for improvement in lots of cases. A gripe against some of them (although not exactly a legitimate one) from the maintenance man's viewpoint is the easy way they claim their machine can be repaired. The boss reads the book about taking apart assembly A by removing cotter key B, nut C, and loosening tapered pin D by gently tapping around edge of pin hole E, and takes off for the week end, happy that his repair crew has an easy job for Sunday. There is a hard time Monday explaining the five long, hard hours that was necessary to remove pin D, graduating from a gentle tapping in the approved manner to the final pounding with the biggest sledge hammer in the place wielded by the biggest man.

Summing up, the manufacturers should take a look at their equipment toward simplication of repair work. The instruction book should be based upon the experience of their service engineers, with all the various shortcuts and know-hows that the latter have acquired and which the maintenance man learns the hard way through trial and error. They should furnish a clear and detailed print with an accompanying parts list accurate for the particular model supplied. When improvements or changes are made in particular parts of the model and are sent on replacement orders, a print of the changed parts should be sent along for their customer's future guidance in ordering repairs. And last but not least, all units should have serial numbers or some means of identification.

Plant Designers Must Provide Space and Headroom

Assuming that the head office engineers have purchased the proper equipment (a little room for argument there sometimes), the plans for the actual installation should be carefully drawn with an eye out for the minor maintenance necessary and also major overhauls. Admittedly, in lots of cases the new equipment has to be pried into an existing space which leaves little lee-way in installation design. However, in cost cases there is enough room to shift the units around slightly to facilitate repair.

The trend to set units closer to the floor is a step in the right direction. A turbine bearing's oil rings that can be checked by merely bending over will receive a lot more attention than those you have to be a first cousin to a monkey to glimpse.

Headroom requirements set by the manufacturer should be carefully checked and enough additional room added to allow for lifting equipment, a fact sometimes overlooked. Piping and valves should be arranged to provide isolation of the unit without shutting down half of the plant, and also that they are not too much in the way of repair work. Valves should be placed in fairly accessible locations, otherwise they will not be cared for properly and the time will come when they will be useless, generally when most needed. All automatic controls should have provisions for hand operation.

Where an outside contractor is to do the job, the plans must be ex-

RAPID REACTORS

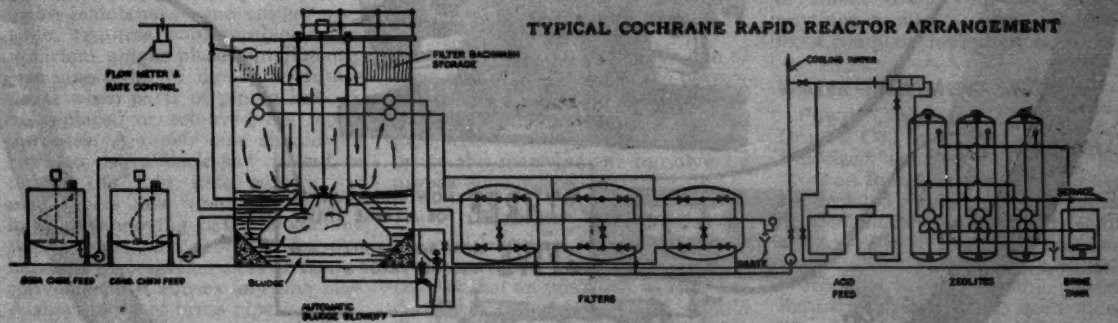
COMBINING the basic elements of equipment for mixing, floc formation, settling, and thickening in a single reaction vessel, the Cochrane Rapid Reactor is finding widespread application in industry for the conditioning of process cooling water and boiler feed. Chemical reagents may be introduced for coagulation of turbidity alone, for partial softening with coincident turbidity reduction, or for complete softening and turbidity reduction. The choice of reagents will be governed by the characteristics of the raw water and the purpose for which the treated water is to be used.

By its improved design, the Cochrane Rapid Reactor permits chemical reactions and separation of coagulated solids in only a fraction of the time necessary in intermittent cold process softeners. The retention time in a Cochrane Rapid Reactor will depend upon conditions, but usually is of the order of 60 to 70 minutes, as compared to four hours or more with conventional cold process softeners or clarification systems.

This improvement is attained by scientific application of an old principle of sludge recirculation in which the sedimentation tank is so arranged with forced pumping of the sludge that when the chemicals are added to the incoming water they react in the presence of large quantities of sludge; the sludge seeds the precipitation and accelerates the chemical reactions. In addition to the acceleration of the chemical reactions the initial precipitate, which is colloidal in nature, is rapidly coagulated and separated from the water. From this fact the device derives its name "Rapid Reactor."

Write for a copy of Publication No. 4425

TYPICAL COCHRANE RAPID REACTOR ARRANGEMENT



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BOILER FEED PUMPS

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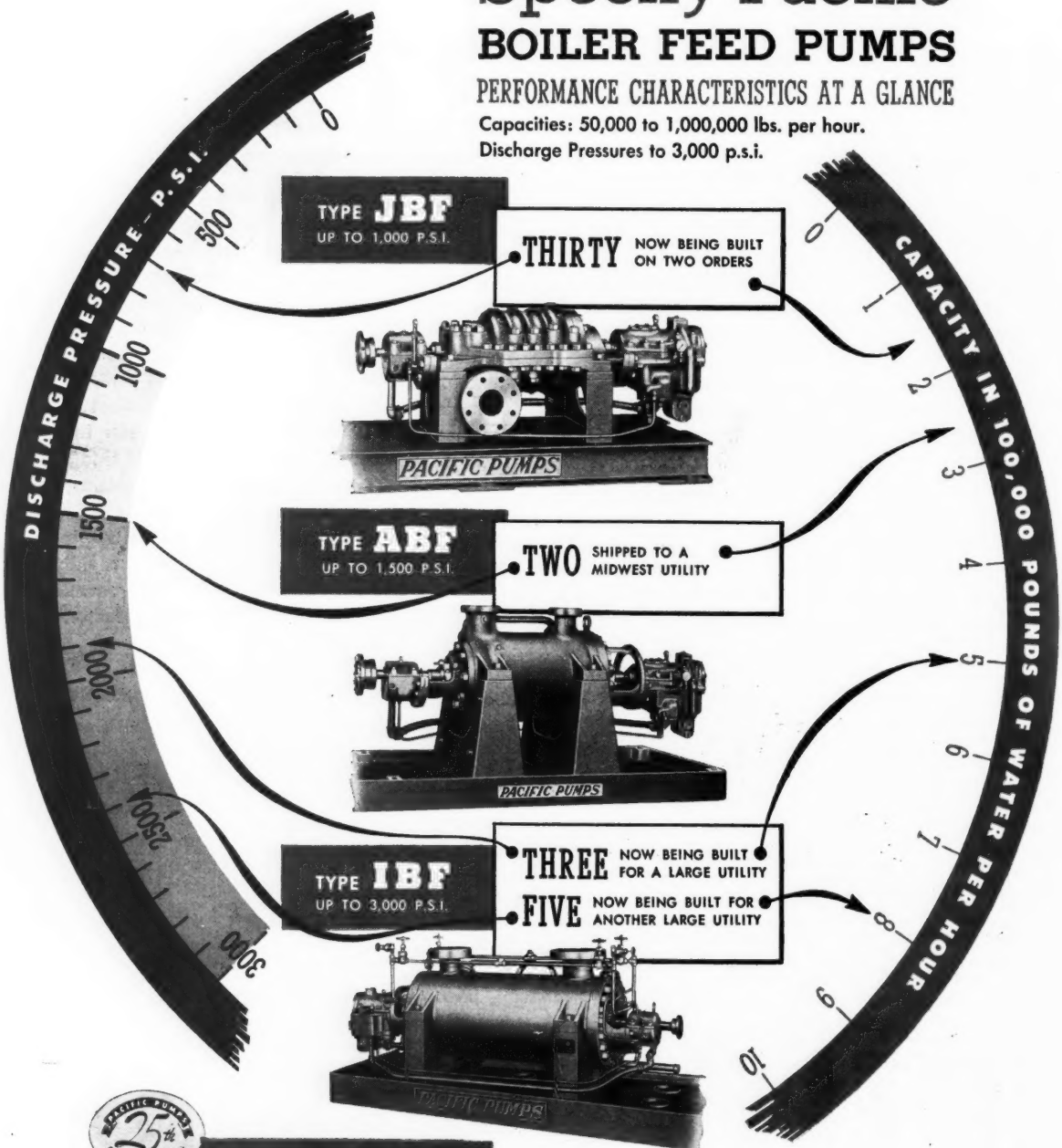
Capacities: 50,000 to 1,000,000 lbs. per hour.
Discharge Pressures to 3,000 p.s.i.



PACIFIC PUMPS 25th ANNIVERSARY

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BF-3

Fig. 4. . . . the way to get a valve there is to show it on the contractor's print

ceptionally well drawn, showing in detail everything that the contractor is supposed to do. For instance, valves left off the prints at this stage are not included in the contractor's bid, and a lot of heated discussions take place in getting the valves installed.

It is the duty of the chief engineer to see that the plans are correct, and to sell the management on the idea of spending a little more, if necessary, to provide better servicing conditions. The men responsible for the maintenance and operation of the new units should be provided with sufficient time to follow closely the installation. If a manufacturer's service engineer is on the job, much valuable information can be secured by the asking of questions.

Pipe, Fittings, Proper Light and Tools

Close supervision of pipe fitting and electrical crews is necessary. The larger piping and fittings are located on the blueprint, but a considerable amount of latitude is given for the smaller service piping. Location of valves, piping and fittings to make maintenance the easiest possible, requires considerable study. Sufficient unions placed intelligently can save a lot of money in future times when parts of piping have to be replaced or removed for repair purposes. A repair man should not have to use a hack saw to cut in unions the first time repairs are made to a new unit. Electricians have an annoying habit of sticking their boxes and conduit in the handiest places, regardless of the inconvenience it causes any one else. A short piece of brass pipe is sometimes a big help in persuading them to listen to reason.

Makeshifts Cost Money

Water, compressed air, and light extension outlets should not be doled out as though the company was losing its life blood drop by drop. Getting outlets where needed around power plants is generally accompanied by loud arguments and name calling. Anyone who has ever played around with two or more light extension cords tied together on a repair job can testify that an enormous amount of money is wasted in this way, not counting the wear and tear on everyone's dispositions. Such makeshift arrangements always cause trouble, idling at least one and possibly several men when a bad connection develops somewhere along the line, which invariably happens. A gold-plated outlet could be put in for far less than what some of these hookups cost in unproductive labor costs.

A factory that prides itself upon its service facilities and lighting arrangement will have a power plant where the operators grope their way around in semi-darkness, each man having to carry a flash light to carry on his work. One repair bill for an operator error under these conditions could pay for an excellent lighting system.

It is up to the management to supply proper tools for repair work. In large plants, the checking of the whereabouts of the tools is relatively an easy matter. In smaller plants, however, where the same set of tools may be used by different persons throughout the various shifts, and must of necessity be left in the open, tools have a habit of disappearing. Penalizing the entire crew for such losses is a questionable form of economy. The labor cost of half a

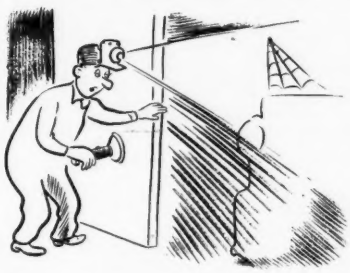


Fig. 5. . . . some plants have to operate by flashlight

dozen idle men waiting while one of their number is out trying to borrow or steal a pipe wrench so the job can proceed, could pay for several pipe wrenches. Such problems are up to the management to solve by proper supervision.

Train Men Properly

A skilled man versed in power plant operation should not be used on jobs that an unskilled worker can do. The experienced man should spend his time on checking existing equipment and controls to improve operation, locating trouble or possible sources of trouble as it starts, and correcting it before it gets too bad. Using such a man to shovel combustion from a boiler is a sheer waste of talent, and the company is the biggest loser.

Plant operators should be trained sufficiently for the job. It would pay big dividends in reduced maintenance cost to carry on a continuous training program, for operators on various shifts are more or less on their own, and develop some careless and sometimes dangerous practices. With an alert and well trained operating staff taking good care of the equipment, only maintenance for normal wear would have to be undertaken.

Those in charge of maintenance should study the operation of all units, for only by knowing the underlying theory can obscure troubles be diagnosed. The ability to observe and locate trouble is more important in a maintenance worker than actual skill with tools. One of the best mechanics ever in our boiler room from the standpoint of skill with the use of tools was helpless at repairing a CO_2 recorder, simply because he never took the trouble to learn the theory of operation. New machines should be looked over critically with an eye to possible repair problems.

A sufficient supply of repair parts should be kept in stock, so that when a unit is taken down for repair of one item, other parts found defective can be replaced at the same time. This saves duplication of work. Small gaskets that are tedious to cut out are cheaper to buy from the manufacturer. In fact, lots of control units depend upon a certain gasket thickness for the proper clearances of their operating parts. Matching gasket thicknesses is sometimes a time-consuming job, and the purchased product is generally much better.

The maintenance man should speak out whenever he notices anything that is not correct. If he doesn't ask for the proper tools, service facilities where he needs them, or a change in operating procedures when repairs become excessive, he will never get them. Those in authority are of necessity hard-headed and it takes a pretty good argument to win your case. To get anything around a power plant you must complain loud, long and often.

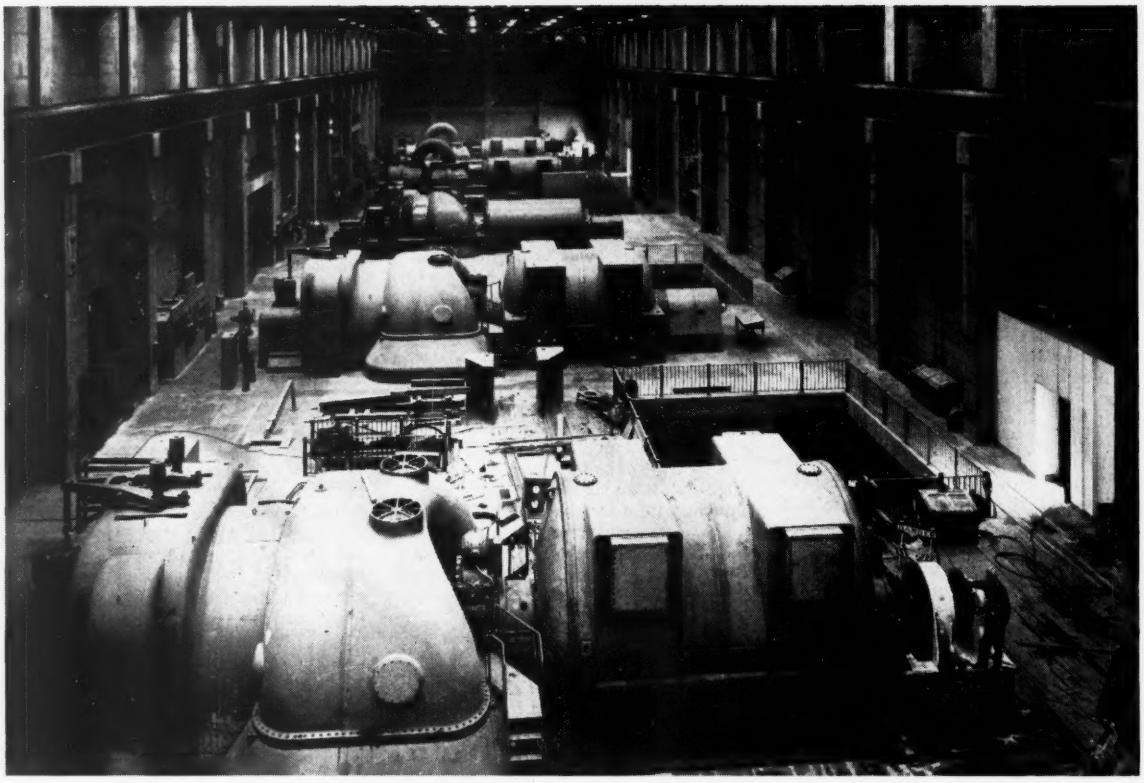
WATER TREATMENT COURSES

Power Chemicals Division, E. F. Drew & Co., Inc., of New York City will again conduct a series of lectures on Industrial Water Treatment and related problems. The course, divided into a series of four lecture and discussion meetings, has been given in New York, Newark, Buffalo, Worcester, Mass., and other eastern industrial areas and has been widely attended by plant operating personnel. This year, for the first time, the course will be held in the mid-west and in Philadelphia.

The lectures and discussions will be conducted by Dr. R. C. Ulmer, Technical Director, Power Chemicals, Division, E. F. Drew & Co., Inc.

Registration is by application to E. F. Drew & Co., Inc., 15 East 26th Street, New York City, or at the first meeting of the course. The meetings will be held on the following dates:

Cleveland, Oct. 3, 10, 17, 24—Hotel Cleveland; Detroit, Oct. 4, 11, 18, 25—Hotel Tuller; Chicago, Oct. 5, 12, 19, 26—Hotel Gibson; Cincinnati, Oct. 6, 13, 20, 27—Hotel Midland; Philadelphia, Nov. 2, 9, 16, 30—Hotel Essex.



General view of turbine room at Harbor Steam Plant, Department of Water and Power, City of Los Angeles, as it now appears, with Unit No. 5 in the foreground

Unit No. 5 on the Line at Harbor Steam Plant

UNIT No. 5, a 75,000 kw steam turbine generator, began spinning in July at the Department of Water and Power's Harbor Steam Plant, Island Avenue and B Street, Wilmington, California.

This is the final unit for which the huge plant was designed, and brings the plant's generating capacity up to a total of approximately 350,000 kw, which is about three-fourths of the energy available to Los Angeles from Hoover Dam power plant, according to Samuel B. Morris, general manager and chief engineer.

Work on the $42,000,000 plant was started in early 1941, and the first unit, of 65,000 kw capacity, went into service in June of 1943, just in time to avert a shortage of electric power that would have seriously affected war production in Los Angeles. (See, Harbor Steam Plant Goes on the Line, *Power Plant Engineering*, June 1943; The Harbor Steam Plant Turbine, *Ibid.* February, 1945; The Harbor Steam Plant Boiler, *Ibid* June, 1945.)

Because of wartime restrictions, the first plant expansion was delayed until November 1 of 1945. Two years later, almost to the day, Unit No. 2 also of 65,000 kw capacity went into service.

During the construction of Unit No. 2, the city's continued growth, and the rapid conversion of war plants to peace time production, increased local power demands to a far greater extent than was anticipated by Department engineers.

In order to serve the growing load, work was started on a second plant expansion many months ahead of the original schedule. This second expansion just completed, brings the plant up to its full installed capacity of 350,000 kw, and makes the plant one of the largest modern steam generating stations in the United States, it was stated by Charles P. Garman, chief electrical engineer.

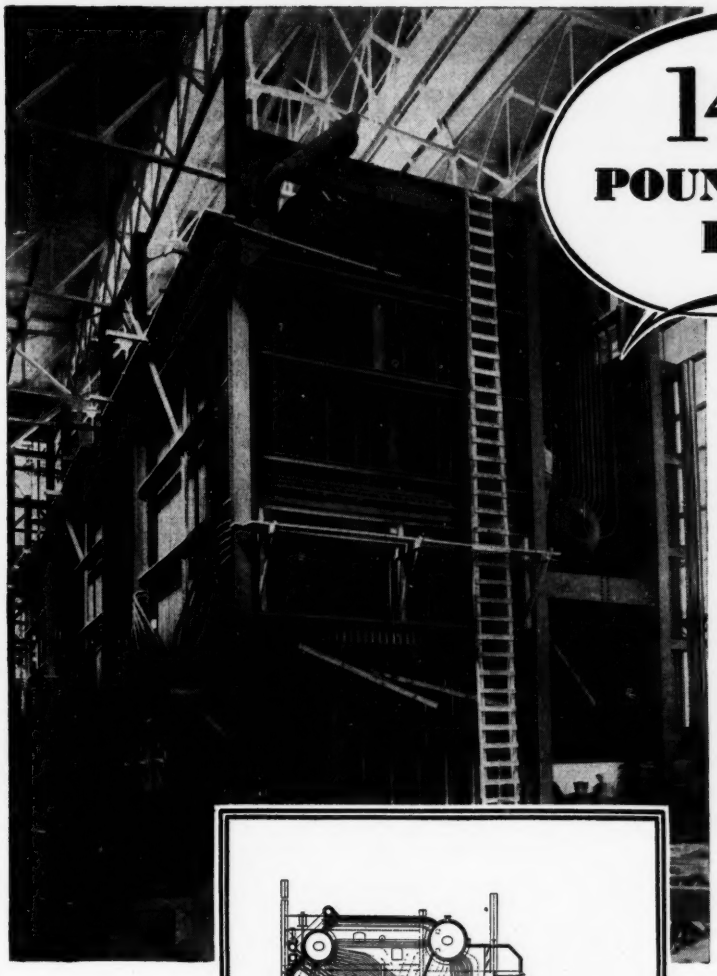
The new turbine generator is 61 ft long and 16 ft high. It operates at a speed of 1800 rpm.

Energy source of the new unit is its boiler, 42 ft wide, 62 ft deep, and the height of an 8-story building. It is fired by 12 oil burners, can produce 650,000 lb of steam an hour at 950 psi, 900 F. All five units, in full operation, consume 110 barrels of fuel oil an hour, 416,000 barrels a month. This is a daily equivalent of 37 railroad tank cars.

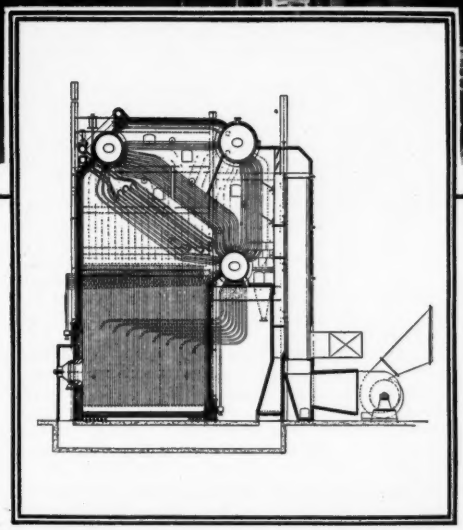
Plant facilities include a complete water treatment plant, a machine shop for emergency repairs, an instrument repair shop which will service all instruments, about 1000 for each of the five generating units, a chemistry laboratory and a warehouse.

On-the-spot de-scaling of fouled heat exchanger tubes with specially developed mechanical cleaners was discussed at the last annual meeting of the ASME by A. John of Thomas C. Wilson, Inc. In his report, Mr. John pointed out the many advantages of the direct-drive air-operated mechanical tube cleaner, particularly where tubes are badly fouled or plugged. This outside suspension type cleaner can be regulated with finger-tip pressure. The hollow rotary shafts come in lengths suitable to the heat exchanger being cleaned. Either air, water or steam can be used as the scavenging agent. Typical applications of both heavy-duty and light-duty cleaners were given.

The paper also presented data on electrically-driven flexible-shaft tube cleaners for use in confined quarters or where compressed aid is not readily available. Clean-outs of return bend type of heat exchanger as well as the use of turbine type cleaners for de-scaling boiler tubes were discussed. A copy of this paper can be obtained by writing to the editors.



140,000
POUNDS OF STEAM PER HOUR



Number of Erie City Steam Generators.....3

Pounds of Steam/Hr..140,000

Design Pressure.....450 lbs.

Operating Pressure...425 lbs.

Steam Temperature..725° F.

Heating Surface—
Erie City Boiler
12,610 Sq. Ft.
Erie City Water Walls
2,312 Sq. Ft.
Erie City Air Heater
12,000 Sq. Ft.

Final Exit Gas Temp..401° F.

Method of Firing
Gas and Oil

STEAM POWER PLANT EQUIPMENT

Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizer • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

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POWER PLANT *Construction News*

Downey, Calif.—Arrowhead Rubber Co., 2244 East 37th St., Vernon, Los Angeles, Calif., mechanical rubber goods, plans boiler plant at new mill on South Patton Rd., Downey. Work will begin soon. Entire project estimated to cost over $500,000. Jack MacDonald, 1013 East 8th St., Los Angeles, is engineer.

Washington, D. C.—House Office Buildng Commission, House Office Bldg., plans new steam-generating station for central-heating service for all buildings on Capitol Hill, with installation to include two complete steam-generating units using coal as fuel, with stokers, pumps and auxiliary equipment. Proposed to discontinue present electric power plant and use central-station service in future, with power substations and other facilities. Entire project estimated to cost close to $16,400,000.

Tampa, Fla.—Florida Power Corp., St. Petersburg, Fla., is reported planning new power plant for auxiliary service in vicinity of Tampa. Kuljian Corp., 1220 Broad St., Philadelphia, Pa., is engineer and will supervise construction.

Atlanta, Ga.—Construction Service, Veterans' Administration, Vermont Ave. and H St., N.W., Washington, D. C., plans steam-generating plant for central-heating service at new hospital at Atlanta, comprising a large group of one and multi-story institutional buildings. A refrigerating plant will be installed, with air-conditioning system and other electrical and mechanical facilities. Cost about $9,000.000. Plans are in progress and bids will be asked in near future.

Russell County, Ky.—Corps of U. S. Engineers, Army Dept., Office of District Engineer, Memphis, Tenn., is asking bids until Oct. 18 for construction of hydroelectric power plant at Wolf Creek dam, Cumberland River, Russell County, as per plans and specifications (Invitation 3).

Crown Point, Ind.—Northern Indiana Public Service Co., Hammond, Ind., has approved plans for new power station near Crown Point, and will begin erection soon. No estimate of cost announced.

Cedar Rapids, Iowa—Iowa Electric Power & Light Co., has begun foundations for new addition to local power plant, 80 by 100 ft, and will use it for expansion in turbine department, with installation of new generating unit and auxiliary equipment. Howard R. Green Co., 417 First Ave. East, Cedar Rapids, is architect.

Cheverly, Md.—Board of Prince Georges County Commissioners has plans under way for boiler plant for central-heating service at Prince Georges general hospital, Cheverly. Paul Kea & Associates, Professional Bldg., Hyattsville, Md., are architects.

Ypsilanti, Mich.—State Building and Construction Dept., State Capitol, Lansing, Mich., will have plans prepared by E. R. Little Co., Kales Bldg., Detroit, Mich., consulting engineer, for new power plant at State Normal College, Ypsilanti. Cost estimated about $1,000,000. Bids are expected to be asked before close of this year.

Minneapolis, Minn.—Northern States Power Co., 15 South Fifth St., has arranged financing in amount of $15,000,000, to be used in connection with 1949 expansion and improvement program in plants and system, entire project to represent reported investment of about $50,000,000. Work will provide for total increase in generating capacity of 104,-500-kw. Program will be continued in 1950, when close to 100,000-kw, additional capacity will be developed. Further expansion in 1951 and 1952 will increase generating capacity by 20,500-kw and 60,000-kw, respectively, according to present plans.

Lincoln, Neb.—Nebraska State Bd. of Control, State Capitol Bldg., Charles Kuhle, secretary, plans new multi-story power house at local State Hospital, estimated to cost about $130,000, exclusive of equipment. Proposed to carry out work this fall. Fritz Craig, First National Bank Bldg., Lincoln, is architect.

Scottsbluff, Neb. — Consumers Public Power District, Columbus, Neb., has authorized plans for expansion and improvements in steam-electric generating station at Scottsbluff, with installation of additional equipment. Cost reported over $1,000,000. Proposed to carry out work this fall.

Salisbury, N. C.—Construction Service, Veterans' Administration, Vermont Ave. and H St., N. W., Washington, D. C., plans steam-generating plant for central-heating service at new hospital on 400-acre tract of land at Salisbury, comprising a large series of institutional buildings. Also will provide electric power plant, refrigerating plant, air-conditioning system, and other mechanical and electrical facilities. Entire project will cost about $17,000,000. Plans will be prepared soon. Walter Hook & Associates, 303½ West Fourth St., Charlotte, N. C., are architects; W. H. Deitrick, Inc., 115 West Morgan St., and William C. Olsen, 5 Exchange Pl., both Raleigh, N. C., are engineers.

Portland, Ore.—Oregon State Board of Control, State Capitol Bldg., Salem, Ore., plans boiler plant for central-heating service in new State office building at Portland, for which appropriation of $2,500,000 is available. Architect will be selected soon to prepare detailed plans.

Clairton, Pa.—Duquesne Light Co., 435 Sixth Ave., Pittsburgh, Pa., will begin superstructure soon for new steam-electric generating station on Monongahela River, near Clairton, with turbine-generators, high-pressure boilers and auxiliary equipment for large capacity. Plant will require close to 30 months for completion and will represent a reported investment in excess of $26,000,000, including transmission lines, power substations and miscellaneous structures.

McKeesport, Pa.—National Tube Co., Frick Bldg., Pittsburgh, Pa., steel pipe, tubing, etc., has approved plans for new steam-generating station and gas-washer plant at works at McKeesport, estimated to cost close to $1,000,000, with equipment. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

Sioux Falls, S. D.—John Morrell & Co., Sioux Falls, meat packer, plans addition to boiler house at local packing plant. Additional equipment will be installed. No estimate of cost announced. Helmick, Edeskuty & Lutz, Essex Bldg., Minneapolis, Minn., are consulting engineers. Main offices of company are at Ottumwa, Iowa.

Nashville, Tenn.—City Council, City Hall, has authorized plans for expanding and converting municipal steam power plant for central-heating service for city buildings. Additional equipment will be installed. Cost reported about $250,000. Hart, Freeland & Roberts, Third National Bank Bldg., Nashville, are consulting engineers.

Austin, Texas—City council will proceed with work soon on addition to municipal steam-electric power plant, with installation of equipment for increased capacity. Cost reported about $2,000,000. Burns & McDonnell Engineering Co., 95th and Troost Sts., Kansas City, Mo., is consulting engineer.

Galveston, Texas—Galveston County Board of Commissioners, Galveston, plans standby power plant at new mainland hospital. Power substation will be built for central station service. Entire project will cost about $1,000,000. Proposed to receive bids early in November. Goleman & Rolfe, 915 Woodrow St., Houston, Texas; and Charles L. Zwiener, Central Exchange Bldg., Galveston, are architects.

Longview, Texas—Tennessee-Eastman Corp., Kingsport, Tenn., cellulose products and chemicals, plans power house at proposed new plant near Longview, for production of basic raw materials for use at processing plant at Kingsport. Plans will be prepared in near future. No official estimate of cost announced, but will represent investment of several million dollars.

Rio Grande City, Texas—Continental Oil Co., Ponca City, Okla., plans boiler house in connection with new natural gasoline plant at Rio Grande City, latter to be equipped for large processing capacity. Entire project estimated to cost over $1,300,000. Proposed to carry out work soon.

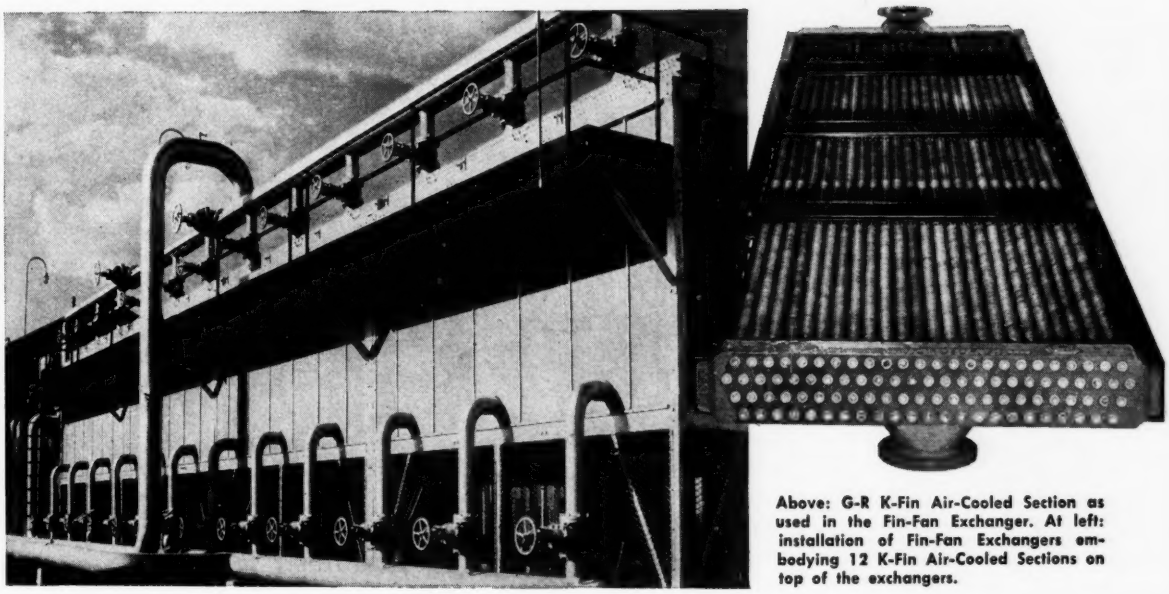
Richmond, Va.—Virginia Electric & Power Co., Richmond, will expend about $15,500,000 for expansion and improvements in power plants and system during remainder of present year, including additional generating capacity, power substations, transmission lines and other facilities.

Alma, Wis.—Dairyland Power Cooperative, Rivoli Bldg., LaCrosse, Wis., has plans under way for expansion in steam division of power plant at Alma, to include installation of new boiler unit and auxiliary equipment. Vern E. Alden Co., 120 South LaSalle St., Chicago, Ill., is consulting engineer.

Chippewa Falls, Wis.—State Dept. of Public Welfare, State Capitol, Madison, Wis., has approved plans for new steam-generating plant for central-heating service at State Northern Colony & Training School, Chippewa Falls, with installation to include boilers, stokers, coal and ash-handling equipment, pumping machinery and auxiliary equipment. No estimate of cost announced. Moe, Weiss & Papenthien, 611 North Broadway, Milwaukee, Wis., are architects and engineers.

Racine, Wis.—Dumore Co., 1300 17th St., electric grinders, tools, etc., has approved plans for new boiler house at plant, in connection with other extensions. Entire project estimated to cost over $75,000. Work scheduled to be carried out soon.

Now you can **condense steam** or **cool liquids** and **gases** by **AIR** in the **FIN-FAN EXCHANGER**



Above: G-R K-Fin Air-Cooled Section as used in the Fin-Fan Exchanger. At left: installation of Fin-Fan Exchangers embodying 12 K-Fin Air-Cooled Sections on top of the exchangers.

At last! . . . a compact, effective, dependable, all-weather *air cooled* condenser and cooler that eliminates the complications, expenses and troubles of water cooling equipment.

The "package-type" self-contained FIN-FAN Exchanger comes to you as a complete unit, ready for erection. It is strongly designed for high pressures and temperatures, can be installed in limited space within a building, on the ground, or on a roof, and it operates with *forced draft,* independent of the direction or intensity of air currents.

This advantageous unit is being used for condensing exhaust steam and refrigeration systems, and for cooling oil, water, process liquids and gases in installations all over the country. Its G-R K-Fin elements with helical fins have proven their superior effectiveness and durability in many thousands of cooling and condensing units; and its fan, fan drive and structure are expressly designed by Fluor Corporation Ltd., who are associated with The Griscom-Russell Co. in the development of these units.

Write for Bulletin 1231 describing the Fin-Fan Exchanger in detail.

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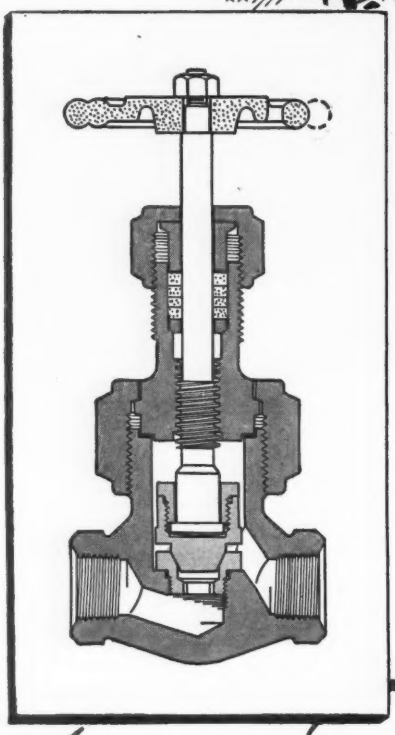
PIONEERS IN HEAT TRANSFER APPARATUS

"We need 300# Globe Valves that we can install and forget..."

"Okeh... specify VOGT Series 3430"*

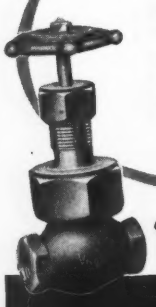


Sturdy drop forged steel valves like these won't let you down. They stay in there pitching year after year on your really tough jobs. Series 3430 valves have drop forged steel bodies and bonnets, 11½-13% chrome stainless steel seats and cone type loose discs. A flat gasket seals the male and female bonnet joint. The stuffing box can be repacked under pressure when the valve is fully open. These valves are also available with 18-8 stainless steel trimmings.

*Series 3430

CARBON STEEL { 300 Pounds @ 750° F. / 600 Pounds Cold Non-Shock

For 150-300 pounds general service Union Bonnet • Gasket Joint • Inside Screw Stem • Renewable Seat • 11½-13% Chrome Stainless Steel Trimmings Sizes ¼" to 2" inclusive.



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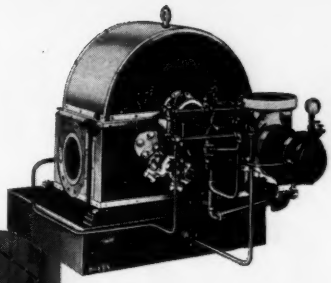
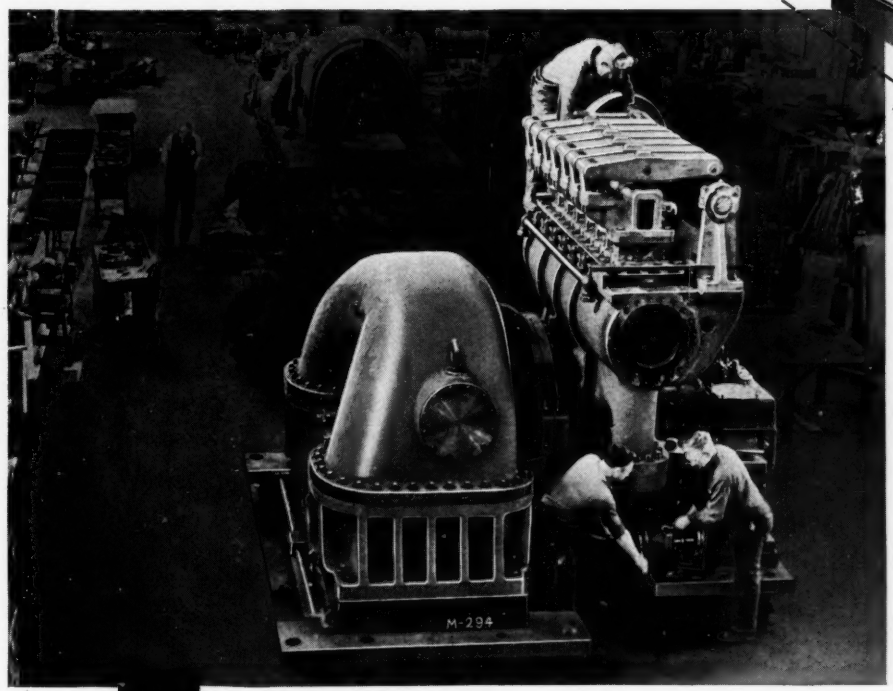
Vogt DROP FORGED STEEL VALVES

Compact, sturdy, dependable. A Worthington single-stage, centrifugal compressor-drive turbine.



FROM SMALLEST SINGLE-STAGE TO MULTI-STAGE GIANTS



A standout for size. One of two Worthington 24,000 hp centrifugal compressor-drive turbines during assembly.

Worthington Turbines Meet the Broadest Range of Drive Requirements

Worthington Turbines offer you unlimited choice of sizes and types — including straight condensing, straight non-condensing, extraction, mixed pressure extraction, low pressure and high back pressure. Steam or gas driven, for mechanical or generator drive, all are available with governors for constant or variable speed, with optional governor-control.

LOWER-COST BLOWER AND COMPRESSOR OPERATION

In the complete Worthington line you'll find the *right* speeds and horsepowers to keep your blowers, compressors and other mechanical drives operating at peak efficiency. And since each Worthington Turbine — from the smallest to the largest — is designed to make steam do more work, you can count on steady power- and money-saving throughout a long, trouble-free service life.

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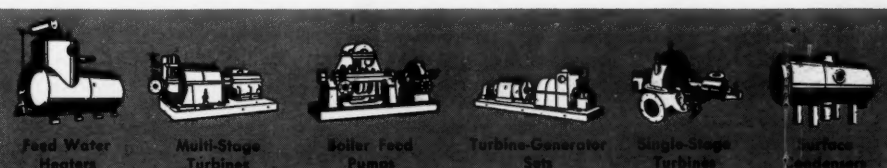
WORTHINGTON

STEAM TURBINES

TS-3

A GREAT TEAM IN STEAM



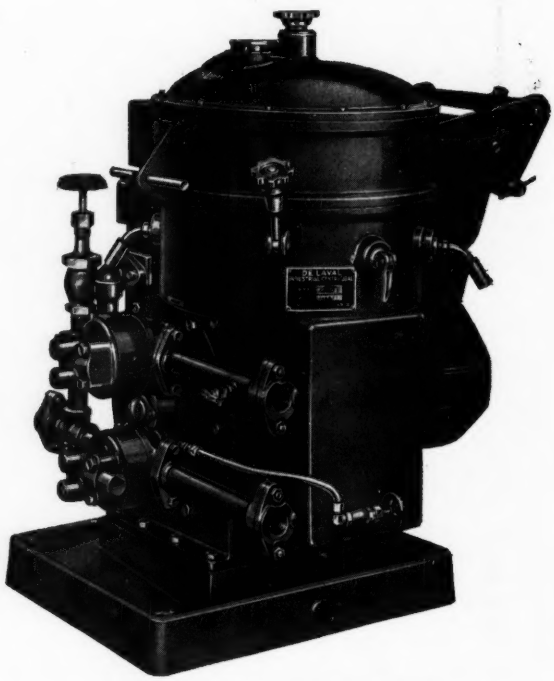
WHEN DO I PAY FOR MYSELF ?

"I am De Laval Centrifugal Force. Working in a De Laval Oil Purifier, I nip trouble in the bud. I protect your power unit from impurities in the lubricating system. I may save you more than you can ever determine!"

Bearing trouble — usually synonymous with lubricating trouble — comes at unexpected or inopportune times. When you get a warning, it is too late.

A De Laval Oil Purifier removes by centrifugal force both of the trouble makers in lubricating systems — water and dirt, or sludge. On continuous by-pass, it keeps the oil in a condition so pure that it can best be compared with new oil. Hence an adequate supply of purified lubricant is always available, and the danger of bearings being "frozen" is reduced to the vanishing point.

The number of bearings saved — or the amount of "down time" avoided — is difficult to evaluate precisely in such cases, just as it is impossible to evaluate a lightning rod in a storm. The chances are that many, many times in the course of a year a De Laval serves to avoid serious trouble, or even a complete shutdown of power-generating facilities. In other words, sooner or later your De Laval will pay for itself.



Model 67 "Uni-Matic" Oil Purifier

The "Uni-Matic" is an integral oil purification unit consisting of Oil Purifier, pumps and—when desired —heater. Several sizes available.

De Laval

THE DE LAVAL SEPARATOR COMPANY
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THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

OIL PURIFIERS *for more dependable power production*

Have Your Boilers Equipped With

ERNSTHRU VISION *Mica Protected* FLAT GLASS INSERTS

THESE ARE THE THINGS TO LOOK FOR:

- STRENGTH
- QUALITY
- WORKMANSHIP
- LIGHT IN WEIGHT
- SIMPLICITY
- GOOD VISION
- EASY TO INSTALL NEW GLASS, MICA & GASKETS

Clear thru vision of water level. Repairs and replacements made easy. No small assembly parts. Mica-protected glass insures long life and clear vision. Liquid chamber and cover plates made of chromium-molybdenum alloy, temperature-resisting steel. Studs and nuts of alloy steel for high temperature. Glass, mica and gaskets made of highest quality obtainable for extreme pressures and temperatures. Center Plate Liquid Chamber tapped for ½" N.P.T. and suitable end Nipples can be furnished. Made to fit any make of Gage Fittings.

FIG. 45 SINGLE INSERT

SINGLE INSERT
FOR PRESSURES TO 650 LBS. W.S.P.
ERNSTHRU VISION
TYPE "E-S-T" FIG. 45

Cat. No.	E-S-T Insert Type	Dim. in In. ± 1/8" A Body Length	Dim. in In. ± 1/8" B Visibility	Approx. Weight
E-2073	1	5¼	3¾	8
E-2074	2	6¼	4¾	11
E-2075	3	7¼	5¾	14
E-2076	4	8¼	6¾	16
E-2077	5	9⅜	7⅞	18
E-2078	6	10⅝	9⅛	21
E-2079	7	11¾	10¼	23
E-2080	8	13⅜	11⅞	26
E-2081	9	14⅛	12⅝	27

FOR PRESSURES TO 900 LBS. W.S.P.
TYPE OF INSERT "E-V-T" SINGLE UNIT

Cat. No.	E-V-T Insert Type	A Body Length	B Visibility	Approx. Weight
E-2088	4	8⅜	6⅞	21 lbs.
E-2089	5	9½	8	24 lbs.
E-2090	6	10¾	9¼	27 lbs.
E-2091	7	11⅞	10⅜	29 lbs.
E-2092	8	13½	12	34 lbs.
E-2093	9	14¼	12¾	36 lbs.

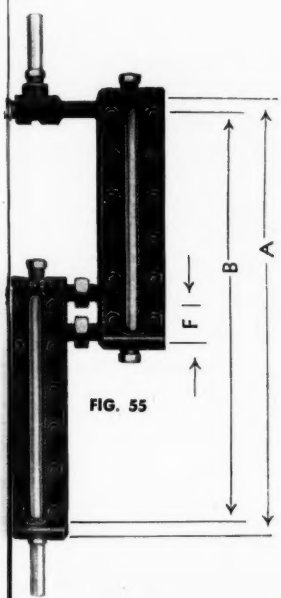


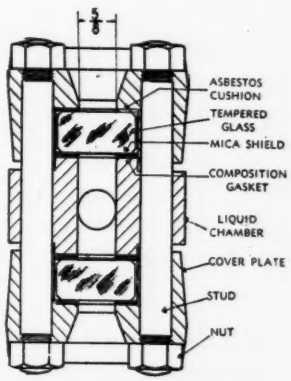
FIG. 55

"DOUBLEUNION" OVERLAPPING INSERT
FOR PRESSURES TO 650 LBS. W.S.P.
TYPE "E-S-T" FIG. 55

Cat. No.	E-S-T Insert Type	B Vision	A Body Length	F Overlap	Approx. Weight
3000	E-S-T 5-5	14	15¾	1¾	41
3001	E-S-T 6-6	16	17¾	2¼	47
3002	E-S-T 7-7	18	19¾	2½	51
3003	E-S-T 8-8	21	22¾	2¾	57
3004	E-S-T 9-9	23	24¾	2¼	59

FOR PRESSURES TO 900 LBS. W.S.P.
TYPE OF INSERT "E-V-T" OVERLAPPING UNIT

Cat. No.	E-V-T Insert Type	B Vision	A Body Length	F Overlap	Approx. Weight
3005	E-V-T 5-5	14	16	2	54
3006	E-V-T 6-6	16	18	2½	60
3007	E-V-T 7-7	18	20	2¾	64
3008	E-V-T 8-8	21	23	3	74
3009	E-V-T 9-9	23	25	2½	78



SECTION VIEW

Inserts for Higher Pressures to Specifications
Write For Prices

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Main Office and Works: 250 South Livingston Avenue, Livingston, New Jersey • Phone: Livingston 6-1400

1 plan helps prevent all 3

When you show the people in your company that you're interested in their welfare, they naturally react favorably. That's why *production goes up* when you boost your employee-participation in the Payroll Savings Plan. Here's how it happens:

The more U. S. Savings Bonds an employee holds, the more secure he feels. The more secure he feels, the greater his peace of mind—the more contented, careful, and productive he is on the job.

Those facts aren't just something we dreamed up. They're borne out in the experience of more than 20,000 companies promoting the Plan.

Everybody Benefits!

Bond sales spread the national debt, thus increasing our national economic security. And, of course, what's good for the nation is good for you and your business!

The individual Bond buyer gets back $4, when his Bonds mature, for every $3 he invested. That's a boon for him, and —multiplied by millions of Bond holders —represents a huge backlog of purchasing power that will help assure national prosperity through the years ahead.

Five Steps Boost Participation

1. See that a top management man sponsors the Plan.

2. Secure the help of the employee organizations in promoting it.

3. Adequately use posters and leaflets and run stories and editorials in company publications to inform employees of the Payroll Savings Plan's benefits to them.

4. Make a person-to person canvass, once a year, to sign up participants.

These first four steps should win you 40-60% participation. Normal employee turnover necessitates one more step:

5. Urge each new employee, at the time he is hired, to sign up.

Nation-wide experience indicates that 50% of your employees can be persuaded to join—without high-pressure selling. All the help you need is available from your State Director, U. S. Treasury Department, Savings Bonds Division. He is listed in your telephone directory. Wouldn't it be a good idea to call him right now, while it's on your mind?

The Treasury Department acknowledges with appreciation the publication of this message by

POWER GENERATION

This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and The Advertising Council.

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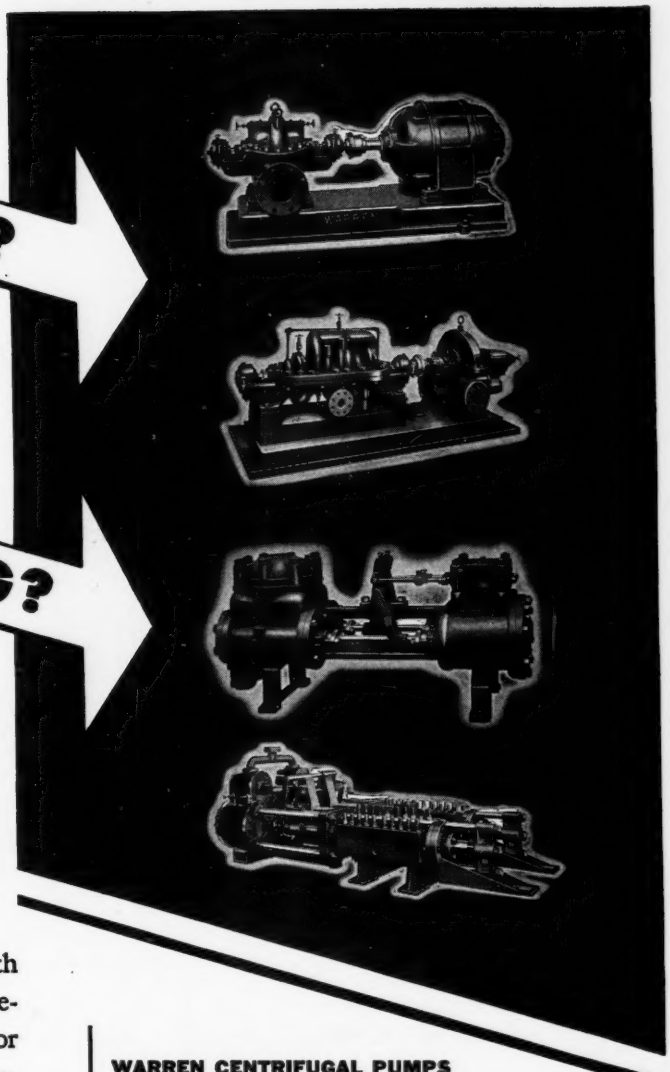
RECIPROCATING?



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WARREN

Recommendation

Warren makes a wide range of both types of pumps. And if you have a special problem that needs a special pump or application, Warren will engineer it for you.

Long, highly specialized experience as pump makers *exclusively* is at your disposal. Put your problem up to Warren. Every possible step will be taken to justify your confidence.

"A Warren recommendation is never a compromise"

WARREN CENTRIFUGAL PUMPS

Single and multi-stage
Pressure range: 0 to 1200 P. S. I.
Capacities: 5 to 50,000 G. P. M.
Types: Horizontal and Vertical
Impellers: Open or closed
Casings: Horizontal or Vertical Split, cast iron or bronze
Bearings: Sleeve or ball-bearing

WARREN RECIPROCATING PUMPS

Horizontal and Vertical single piston
Horizontal and Vertical duplex piston
Single and Duplex Outside Packed Plunger
Single, Duplex and Compound Hydraulic
Steam Heat Vacuum
Automatic Pump and Receiver, etc., etc.

P-20

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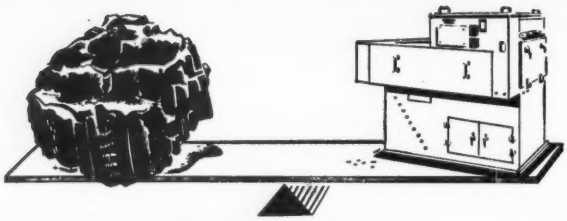
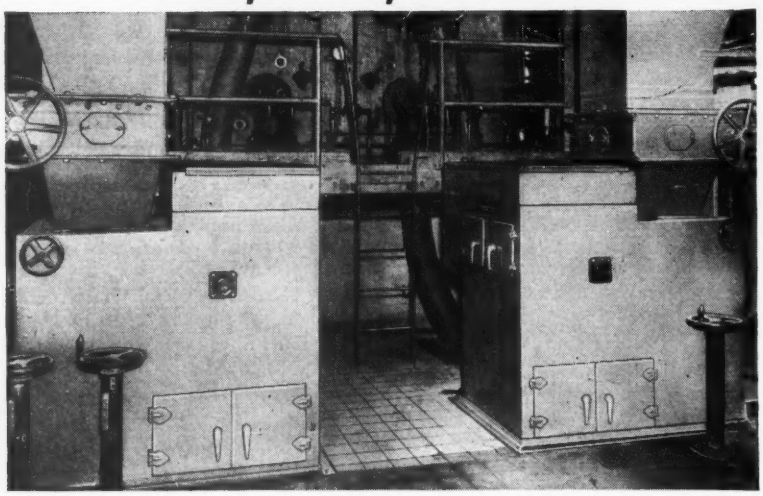
WARREN PUMPS

CENTRIFUGAL AND RECIPROCATING

For Power Plants --- Chemical Plants --- Paper Mills --- Food Industries --- Metal Working --- Oil and Mining Services



helping balance a 440,000,000 ton-diet



Two Richardson 200 lb. Coal Scales at Rockland Light and Power Company's new Hudson Plant.

The total annual rated capacity of Richardson Coal Scales serving steam generating plants in public utilities and industrials is greater than the estimated 440 million tons of coal consumed industrially throughout the nation last year.

Leading surveys of latest developments in central station and industrial power plant design trends emphasize the importance of fuel economy. When it comes to checking coal consumption the reasons for preference for Richardson Scales are obvious. By weighing every ounce of coal accurately to ¼ of 1%, day in and day out, they provide a positive check on coal used in relation to power produced...identify wasteful boilers and permit correction of inefficiencies before fuel losses become serious. Thus they contribute importantly to lower power costs.

The extensive Richardson line of equipment for weighing, conveying and feeding coal includes a model ideally suited to your space layout and capacity requirements... stationary floor-mounted models, stationary and portable models mounted at mid-section, and combination conveyor and elongated scales. Dust-proof, pressure-tight housing contributes substantially to plant cleanliness.

Why not trust Richardson's unrivalled experience—50 years old—to weigh your coal from bunker to stoker (or pulverizer)? Hundreds of public utilities, municipalities and industries do.

RICHARDSON

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New ENGINEERING BOOKS

The Watts Bar Steam Plant by the Tennessee Valley Authority; 325 pages; plus 15 tables and 56 large line drawings; size 6 by 9 in.; illustrated; cloth binding. Available from the Tennessee Valley Authority, Treasurer's Office, Knoxville, Tenn. Price $2.25.

Readers of Power Generation and other technical magazines containing technical descriptions of steam power plants, who desire to see a really complete description of a power station, right down to the last bolt and nut, should get a look at this publication. It treats the Watts Bar Steam Plant in every detail, just as the other reports in the series, covering the various hydro-electric projects of TVA, have treated those.

It gives the most detailed data on the planning, design, construction and initial operation of one of the most modern installations of its kind.

The report also includes a comprehensive summary of the project costs, broken down in great detail to show the contract purchase price of every item of equipment. There is a complete statistical summary of the physical features and 56 selected drawings show every detail of structures and mechanical and electrical installations, including coal handling and storage equipment, and system and control diagrams.

• • •

Heating, Ventilating and Air Conditioning Guide, 1949; 27th Edition; 1384 pages, illustrated; size 6 by 9 in.; cloth binding; published by the American Society of Heating and Ventilating Engineers, 51 Madison Avenue, New York 10, N. Y. Price $7.50.

Here is the 1949 Edition of the master reference book of the heating, ventilating and air conditioning industry. In this Edition many of the chapters have been revised and enlarged, the technical data section has been enlarged by 80 pages, and the catalog data section has been increased by the addition of up to date products of many additional manufacturers.

As is customary in this Guide, the index is at the front of the book and the directory of manufacturers at the rear. In a pocket on the rear cover is a large reproduction of the Goff Diagram for moist air at standard atmospheric pressure.

In the chapter on fluid flow, the mathematical treatment of fluid flow computations has been enlarged and a section has been added on variable area flow meters. Methods of computing heat transfer coefficients of certain types of walls have been improved. Additional instruments are described. Calculation of solar heat gain through walls and roofs has been simplified. Data on all types of fuel burning equipment, heaters and heating systems has been brought up to date and sometimes rewritten.

In the chapter on refrigeration, a thorough revision improving the presentation of the subject includes a new section on the heat pump and additional pressure-enthalpy charts for ammonia and Freon 12. Other new data are presented on air duct design, industrial exhaust systems, drying systems, transportation, air conditioning and codes and standards. The cross-index of the technical data section has been enlarged for easier reference to the technical text.

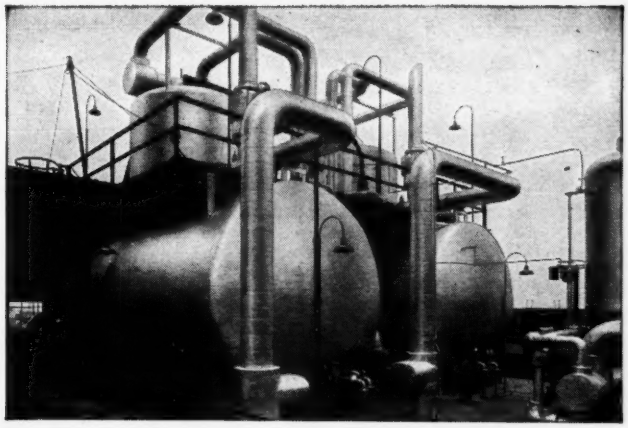
Like previous editions of the Guide, this book is a must for any engineer dealing with heating, ventilating and air conditioning problems.

• • •

Heat Transfer, Vol. 1, by Max Jakob; 758 pages; illustrated; size 6 by 9 in.; cloth binding; published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $12.00.

Here one of the outstanding authorities in the field of heat transfer, the Research Professor of Mechanical Engineering at Illinois Institute of Technology, presents a most complete treatment of conduction and convection from every viewpoint—mathematics, physical theory, experimental data and so on. It includes two chapters on radiation, one being devoted to detailed study of the laws of radiation and the second to radiation properties of matter.

An unusual parallel treatment of conduction, convection and radiation emphasizes their peculiarities and relationships. The first part of the book contains the basic equations; the second deals with the pertinent properties of matter; the third and major section covers heat conduction



3600 POUNDS OF SCALE PER DAY REMOVED FROM BOILER FEED WATER

by GRAVER Hot Process Water Treating System

This is what a Graver two stage Hot Process water treating plant is doing at a large oil refinery. A million pounds of lake water per hour, taken from a canal, is treated as makeup for a battery of high pressure boilers. A million pounds of this untreated water contains approximately 150 pounds of scale forming material. This means about 3600 pounds every 24-hour day. Heaters, sedimentation tanks, filters, and deaerating equipment give the boiler system complete protection against scale and corrosion. If your problem involves treatment of water for boiler feed, process, or industrial waste water treatment of small or large capacities . . . you will find Graver water conditioning equipment does the job efficiently and economically. All types are available, for all jobs, in all capacities. Write today for recommendations and a survey of your water conditioning problem.

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You won't believe any tube cleaner can pack such tremendous power, until you try the new ROTOJET. It removes scale so much faster that it usually pays for itself in one cleaning. Models available for practically any size straight and curved tubes. Send for ROTOJET Bulletin.

THE SECRET

ROTOJET Motor has only two moving parts, a shaft and a paddle. Positive contact between paddle and Rotocentric (egg-shape) bore cylinder prevents stalling at low speeds No leakage Delivers maximum power for air used.

S-530 ROTOJET Air-driven Motor with swing-frame head for 3¼–3-13/16"I.D. straight tubes.

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in simple bodies; and this is followed by sections on heat convection without changes of phase or constitution and heat convection including changes of phase.

The book is intended to serve both as a treatise and textbook and should serve the needs of mechanical, chemical, electrical, civil engineers and physicists alike. The mathematical procedure is explained in some detail. Appendices contain problems to be solved, a list of symbols and other useful data. There is a complete bibliography and an index.

• • •

The Douglas Project by the Tennessee Valley Authority; 439 pages; illustrated; size 6 by 9 in.; cloth binding; obtainable from the Treasurer's Office, Tennessee Valley Authority, Knoxville, Tenn. Price $1.50.

Pianning, design, construction and initial

(Continued on page 132)

* * *

MYERS & ADDINGTON, consulting engineers, have been retained by Jones & Laughlin Steel Corp. for a complete survey to develop recommendations covering modernization of the steam and power supply for their Aliquippa mills.

Myers & Addington also have recently completed the design and supervision of modern boiler plants for Columbia Records Inc. at Bridgeport, Conn., and for Belding Heminway Corticelli, at Putnam, Conn.

* * *

JOSEPH R. DARNELL has announced his availability as a consulting engineer in power plant betterment and as an investigator and engineering consultant in patent and trade mark causes.

For several years, Mr. Darnell has been located in Dallas, Texas, first as the local manager for the B. F. Sturtevant Div. of Westinghouse Electric Corp. and later as an independent consulting engineer. He was a member of the editorial staff of *Power Plant Engineering* (now POWER GENERATION) for several years and is the author of the Boiler Fireman's Handbook now published by this company. He has had long and varied experience as a practicing engineer and designer in the fields of combustion and fan engineering, ventilating, air conditioning and allied subjects. In the early 1920's he was with B. F. Sturtevant Co., then served on our editorial staff, and from there went to the Universal Oil Products Co. where he did research and engineering work in combustion problems and also in connection with the company's technical legal problems.

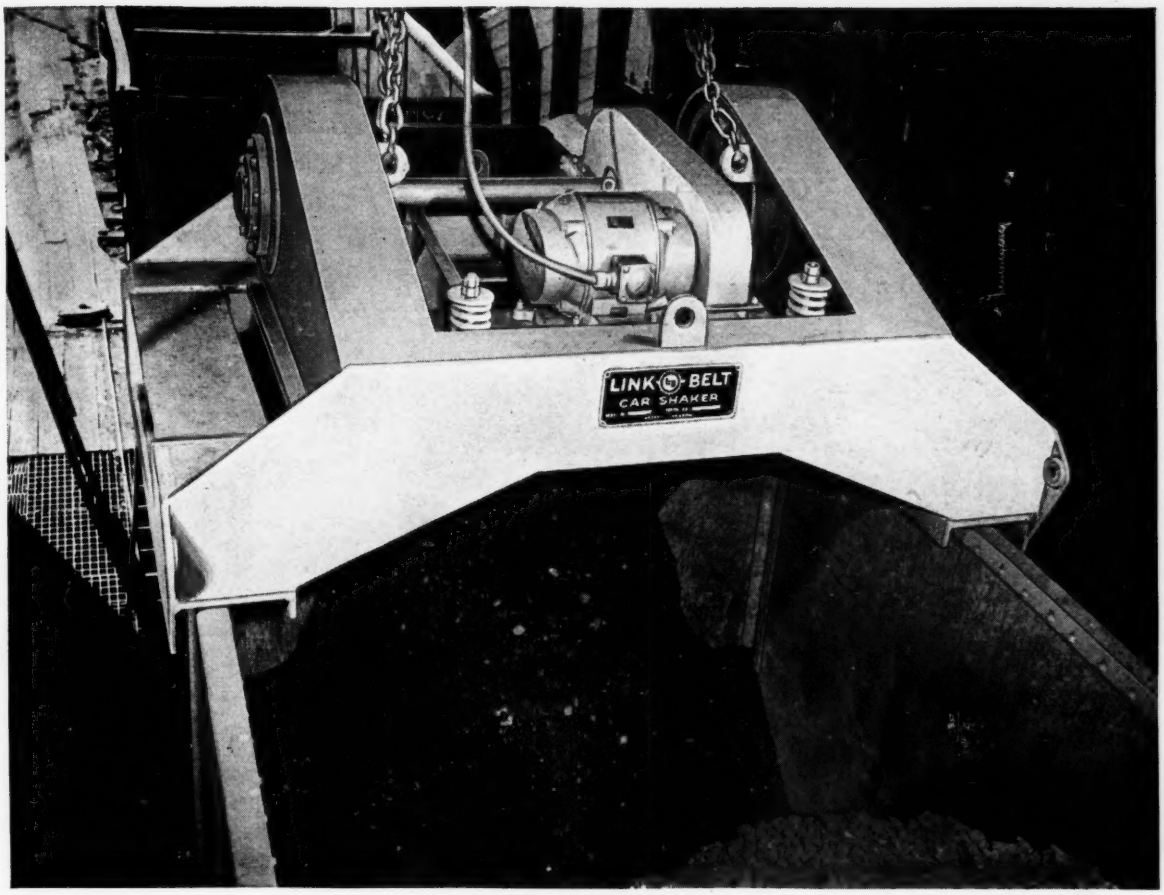
COMING EVENTS

AWC—The Tenth Annual Water Conference of the Engineers' Society of Western Pennsylvania to be held at the William Penn Hotel, Pittsburgh, October 17-19.

NMC-NME—The National Metal Congress and National Metal Exposition sponsored by the American Society for Metals, American Welding Society, Metals Branch, American Institute of Mining and Metallurgical Engineers and the Society for Non-Destructive holding combined annual meeting at the Public Auditorium, Cleveland, October 17-21.

NCIH—The Fifth Annual Meeting of the National Conference of Industrial Hydraulics to be held at the Sheraton Hotel, Chicago, October 26-27.

AIMME-ASME—The Twelfth Joint Meeting of the Coal Division of The American Institute of Mining and Metallurgical Engineers and Fuels Division of the American Society of Mechanical Engineers to be held at the French Licks Springs Hotel, French Licks, Indiana, October 26-27.



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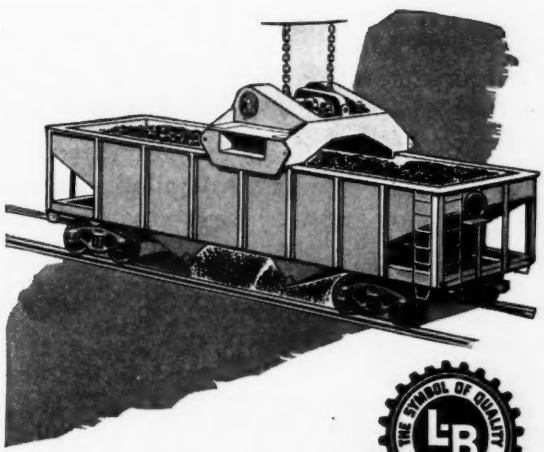
"broom-clean" and fast with

LINK-BELT CAR SHAKER

Lower the Link-Belt Car Shaker to the top of the car walls. Start the motor which delivers vibrations to the car sides and sloping hopper bottoms, loosening the material for easy "broom-clean" unloading in minutes. Reduce unloading costs and injury hazards and eliminate demurrage charges with this efficient unit. It is especially valuable for unloading damp or frozen materials. May we send you full information? Send for Book No. 2345.



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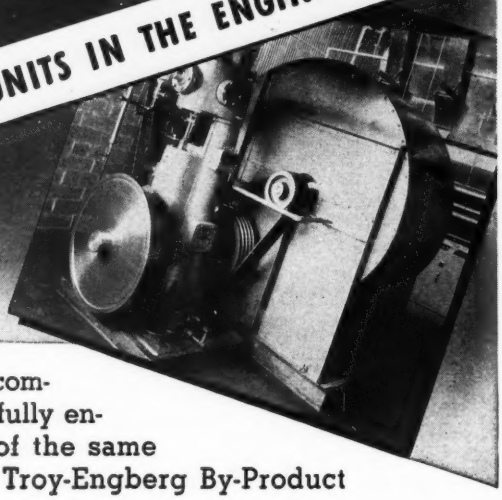
TROY-ENGBERG
STEAM ENGINE

By-Product Power

1 POWER for your stokers, generators, pumps, compressors

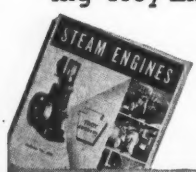
2 HEAT UNITS IN THE ENGINE EXHAUST



And both accomplished by skillfully engineered use of the same steam. This is Troy-Engberg By-Product Power at work.

Use the modern Troy-Engberg Steam Engine to drive stokers, blowers, fans, compressors, mixers, generators and pumps—THEN use the exhaust from the engine for your processing or heating, or both.

Cut Power Costs by putting your steam fully to WORK. Write us for detailed information on applying Troy-Engberg By-Product Power to your plant.



Send for Bulletin 306

TROY ENGINE & MACHINE COMPANY
Established 1870
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TROY-ENGBERG
STEAM ENGINES • GENERATING SETS • GENERATORS

Obituaries

THOMAS G. ESTEP

THOMAS G. ESTEP, who retired this year as Professor of Mechanical Engineering at Carnegie Institute of Technology, died at his home in Alexandria (Pa.) last night.

Professor Estep, who has served on the Carnegie faculty for 36 years before his retirement, was 66.

Born in Alexandria in 1883, he was educated at Pennsylvania State College, where he received a Bachelor of Science in Mechanical Engineering in 1905.

Prior to joining the Carnegie staff, he served with Westinghouse, H. C. Frick Co., Babcock and Wilcox Co., and Armstrong Cork Co. He came to Carnegie in 1913, and served the institution with distinction from that time to his retirement.

As Professor of Mechanical Engineering when he retired, he had served as acting Head of the Mechanical Engineering Department from 1943 to 1947.

Extremely active in his field, Mr. Estep was recently appointed a Fellow in the American Society of Mechanical Engineers. The highest membership rank in the society, a Fellowship is an honorary title granted in recognition of outstanding achievement in the field of mechanical engineering.

He was a member of the Engineers Society of Western Pennsylvania, American Society of Mechanical Engineers, American Association of University Professors, Pi Tau Sigma (honorary mechanical engineering fraternity), Sigma Xi, and the American Society for Engineering Education.

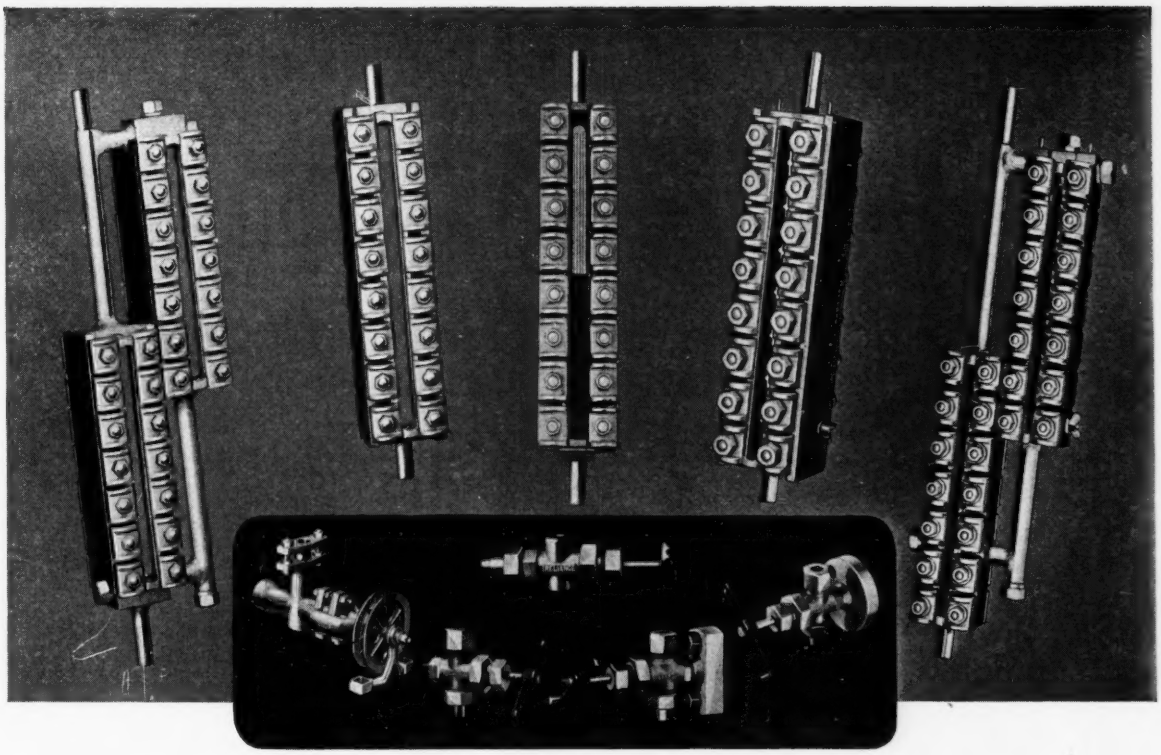
ARTHUR L. JACOBY

DR. ARTHUR L. JACOBY, associate director of research for National Aluminate Corporation, died suddenly of a heart-attack recently, at the age of 39.

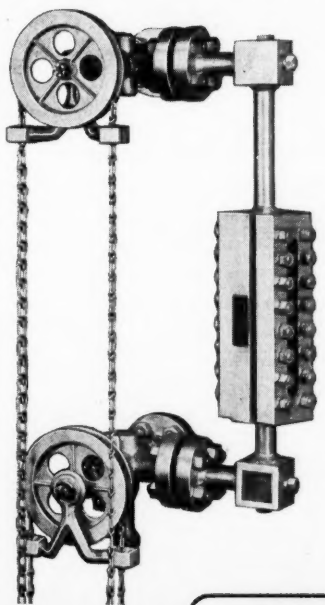
Dr. Jacoby was educated in the Public Schools, and obtained his B.S. degree in Chemical Engineering from the University of Illinois in 1934. He then turned to post graduate work in Organic Chemistry and studied under the famed Professor Henry Gilman at Iowa State College in Ames, Iowa. His Ph.D. degree was awarded by Iowa State College in 1939.

In 1938 Dr. Jacoby entered the industrial research field by joining National Aluminate Corporation as an organic chemist. He later became assistant director of research and then associate director of research, the position he held at his death, for the company.

Dr. Jacoby is survived by his widow, Ruth, a son, John, a daughter, Alice, and two married sisters.



Reliance Water Gage Equipment



for steam-proof and leak-tight service—low cost maintenance

MAKE the "eyes" of your boilers the safe reliable gages they should be to protect life and property—to serve efficiently as the vital basic check on water levels. Make them of Reliance Gage Valves and Inserts. You *know*, then, that you have permanent equipment that won't tax you periodically with repair and replacement expense.

Nearly a dozen styles of Gage Valves give you the means of meeting any connection or pressure requirement. Maintenance is extremely low on Reliance Valves, but when checkup time does come, it's not much of a chore. Gage Inserts made by Reliance cover all needs. PRISMATIC, in which water appears *black*—steam *white*; Mica-protected Flat Glass; and Micasight (all-mica windows), all available in single or double styles to suit any water level visibility range, assure you correct dependable equipment for all pressures. Write for catalog and prices.

BOILER SAFETY DEVICES since 1884

Reliance

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Save Time . . . Labor . . . Money

The New BAUGHMAN Bin-to-Stoker Direct Feed Screw Conveyor

Will Handle 1/2-Ton per Minute

Eliminates wheelbarrowing and shoveling . . . transfers coal at any angle from the horizontal to 60°. Speeds up hopper filling. Practically self-feeding . . . releases manpower for more important duties.

Big 9-inch Conveyor Screw is driven by 2-5 h.p. motor, depending on length. (15 to 50 ft. lengths available.) Direct roller chain and enclosed worm gear case drive at head of shaft. Simple, efficient, trouble-free.

Compact design — quickly adaptable to old boiler rooms and present power plant conditions, or for set-ups requiring a portable unit. Takes up but little room through a wall or doorway.

Open boot end designed for self-feeding as long as fuel surrounds it. Uses tapered screw for more gradual pick-up of materials.

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Casing built of 13-gauge, high-tensile alloy steel—17% stronger, and 5 to 10 times more resistant to rust, corrosion and abrasion than ordinary steel. Arc-welded throughout. Heavy, 9" dia. formed steel screw is electro-welded to 2" seamless pipe.

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HELPFUL BULLETINS

(Continued from page 36)

are future applications and methods of selection of belt conveyors; dimensions, weights and specifications for standard head, tail and intermediate sections; lattice, channel and timber frames; and terminal machinery. Lippmann Engineering Works.

131 **Magnetic Separators** — Twelve-pp Catalog 14 describes permanent non-electric magnetic separators and electronic metal detectors. Specifications regarding weights, sizes and strength comparisons for chute and spout magnets are given as well as tables of operating capacities for permanent magnetic pulleys, drums, pneumatic line assemblies, pipeline traps, ferrous filters and pipe rolls. All equipment is illustrated by photos and engineering drawings. Savings realized through use of these magnets, the importance of application engineering, and the essential of good permanent magnets, are explained. Also discussed are engineering and laboratory services offered by company. Eriez Mfg. Co.

132 **Tube Fittings Chart**—Bulletin 219 is a letter-size display card conveniently listing nomenclature for 14 tube fittings and 5 fitting parts. Shapes are illustrated and described with code designations for each in four types, in steel, stainless, brass and dural. Corresponding AN part numbers are also listed, and a chart relating tube size numbers with tube OD's and pipe thread sizes is included. The Parker Appliance Co.

133 **Glass Properties**—Bulletin B-83, 16 pp, contains basic information about important properties of three commercial glasses. Covers the composition of glass, its mechanical properties, thermal stresses, heat transmission, electrical properties, corrosion resistance and viscosity. Includes technical data, charts and tables. An interesting booklet—it is believed that much of its material has never before been assembled in a presentation of this type. Corning Glass Works.

134 **Furnace Wall and Arch Construction** — This 28-pp illustrated booklet presents manufacturer's suspended arches and sectionally supported walls and their application to all types of furnace enclosures. Photos and drawings show the use of these steel arches in open hearth furnaces, mill furnaces, annealing furnaces, incinerators, dehydrators, down draft and upshot heaters, boilers. Photos also show construction and exterior finish of supported walls. Includes dimensions of standard arches and charts showing heat loss from manufacturer's heavy-duty "duo-seal" walls and from "duo-seal" thin walls. Laclede-Christy Clay Products Co.

135 **Water Analysis Equipment**—This 22-pp booklet illustrates and describes manufacturer's line of apparatus and test sets specially designed for industrial water testing. Explains applications of equipment listed, giving brief instructions for use, available sizes. W. H. & L. D. Betz.

136 **Inhibitation of Corrosion**—This is a 4-pp analysis of the causes and mechanisms of corrosion of both the bimetallic and monometallic types. Explains use of inhibitors to stifle corrosion and tells merits of manufacturer's chrome inhibitors. Wright Chemicals Corp.

137 **Reference Bibiliography for Water, Sewage and Power Plant Engineering**—This 36 page, letter size, paper bound bulletin consists of a comprehensive and up-to-date listing of the best available sources of information on use of water for drinking and also for boiler feedwater supply; on sewage treatment and industrial waste treatment; and on power plant design and operation. For various reasons, which will not be detailed here, a search for data on these subjects often results in loss of time and effort without satisfactory results. The various fields are allied in some ways, sometimes using similar equipment and methods. At various times a consulting engineer or an industrial power or plant engineer will have need for information on all these fields. The bibliography lists first a number of books and magazines covering water supply, treatment, treatment plant design and operation. Next, publications on the bacteriology of water and sewage. Third, publications covering sewage and industrial waste treatment and chemistry and analysis of water and sewage. Fourth, publications on power station design, operation and equipment and finally standard engi-

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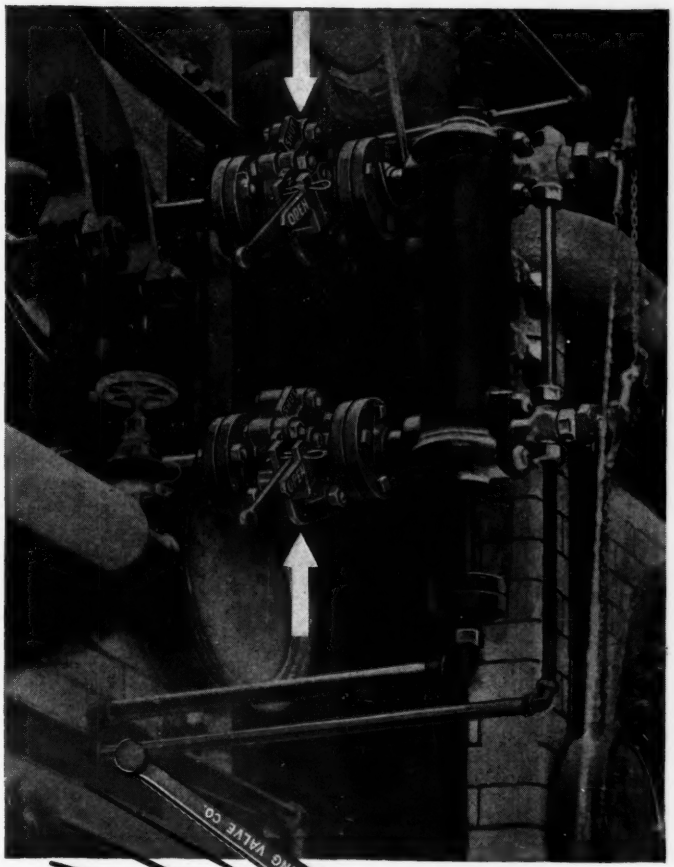

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neering handbooks, data and aid for hydraulic and power engineering. A list of foreign publications is also given. Also a list of periodicals on chemical laboratory procedure, water and sewage, and a good list of manufacturers publications, many of which may be obtained free. Published by Gilbert Associates, Inc.

138 **Electrical and Lubricating Devices**—Four-pp Broadside 300-A presents 13 ways to step up production and cut maintenance costs. A complete, condensed catalog it describes in detail manufacturer's line of fuses, fuse clip clamps, test clamps, fuse pullers and lubrication devices. Trico Fuse Mfg. Co.

139 **Steel Castings**—The long-run economy and other advantages of steel castings are discussed briefly in this 36-pp book, which also touches upon the history of casting metals and the research which has contributed to their development. Book is filled with photographs of castings used in many industries—construction, refineries, rolling mills and blast furnaces, metal working, power plants, electrical equipment. An envelope folder attached to book contains a tabulation of the general engineering types of steel castings, classified according to tensile strength. Steel Founders Society of America.

CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS AND AUXILIARIES

201 **Working Pressure Data Card**—Maximum allowable working pressures for water tube and fire tube boilers are compiled in a handy reference table, Technical Data Card No. 113 A. It lists pressures in pounds per square inch for seamless and electric resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to ASME specifications. Chart covers 2 letter-size pages, is printed on firm stock, and punched for use in binder. The Babcock & Wilcox Tube Co.

202 **Blast Furnace Gas Burner Bulletin**—Said to be the first published on the subject. Bulletin No. 500, 4 pp, describes operation of these burners and discusses their adaptability for use not only with waste fuels, but also in combination with auxiliary fuels and by means of auxiliary fuels alone. Contains pictures of gas burner installations and cross section drawings of various other types of burners for waste and primary fuels. Peabody Engineering Corp.

203 **Steam Generating Equipment**—Bent-tube and straight-tube boilers of several classes are described in detail and illustrated by photos and drawings in this 4-pp bulletin. Also illustrated are some of the valves, heat transfer equipment and refrigeration equipment manufactured by company. Henry Vogt Machine Co., Inc.

203A **Water Tube Boilers**—This 12-pp bulletin illustrates and describes special and standard power plant boilers and packaged steam generators. Includes data and dimensions. Springfield Boiler Co.

VALVES, TRAPS, PIPING

204 **Pipe Distribution System Data** — "Engineering Distribution Data for Underground Steam Distribution," is the title of Section 480-2, 34 pp, of practical usefulness to those who deal with problems involved in insulated piping distribution systems. It covers layout of the route and methods of estimating steam loads, includes steam flow charts and tables, and gives properties of steel pipe, copper water tube piping and saturated steam. Also gives specifications of steam and hot

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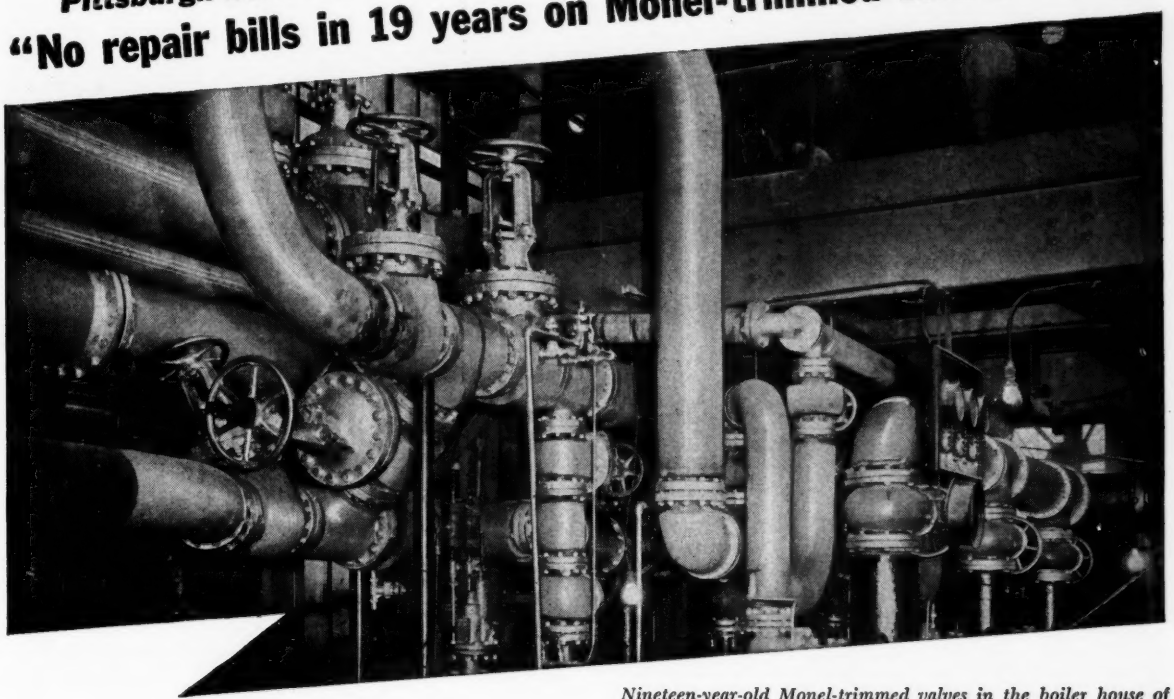

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water distribution piping with prefabricated pipe conduit. It's illustrated with photos of field installations and industrial applications of insulated pipe units, also sketches showing method of making field closures. The Ric-Wil Co.

205 **Piping Materials Catalog**—Corrosion resistant valves and piping materials are covered in illustrated circular No. 320, 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawings of models, complete specifications, sizes and prices. Includes a description of alloy metals used and a corrosion questionnaire. Also included are several pages of condensed recommendations on the selection of piping materials according to service requirements as well as a pictorial chart showing basic types of valves with names of their component parts. Crane Co.

206 **Steam Specialties**—Here is a collection of bulletins covering manufacturer's line of thermostatic steam traps, inverted bucket steam traps, float-thermostatic steam traps, radiator traps and valves, alternating receivers and lift traps, self-operated temperature regulators, air venting equipment, water blenders, strainers. All equipment is illustrated by photos, its operation and applications discussed, and its capacities, dimensions and prices listed. Sarco Co., Inc.

207 **Pipe Hanger Catalog** — Ninety-page Catalog 10-D is a valuable buyer's guide for adjustable pipe hangers and supports. Covers hangers for attachments to pipe and to structure, hanger assemblies, spring hangers, hanger rods, pipe supports and related equipment. Each type described and illustrated by photo and dimensional diagram and listed with dimensions and prices. Catalog also includes standard specifications, photos of installations and terms of sale. Indexed for quick reference; punched for filing in binder. Grinnell Co., Inc.

208 **Valves Bulletin**—A new catalog section 12-H describes all types of the company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Details of design including operating mechanism, body design, disk piston, and other features are explained. Dimensional details are given in tabular form accompanied by dimensioned line drawings. A standard materials specification table is presented. Edward Valves, Inc.

209 **Rubber Expansion Joints** — This 8 page bulletin AD 137 tells about the application, construction, styles, service and advantages of the company's line of rubber expansion joints. Other information given, includes "How To Order" and a table of dimensions which is accompanied by dimensioned line drawings. The bulletin is well illustrated. The Garlock Packing Company.

210 **Control Equipment** — General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pitot equipment. Includes capacity tables, dimensional data, specifications, layout drawings. Simplex Valve and Meter Co.

210A **Rubber Expansion Joints**—Four-pp Bulletin D features rubber expansion joints for handling many types of fluids under conditions of vacuum, pressure and temperatures to 250F. Gives specifications, sizes and tells applications. Also illustrates design principle of these joints. Goodall Rubber Co., Inc.

HEATERS, HEATING

211 **Space Heaters**—Bulletin 523, 12 pp, covers forced air space heaters, direct-fired by oil, gas or combination fuel and ranging in output from 400,000 to 2,000,000 Btu, for comfort heating, year-round ventilating, tempering make-up air, process drying and heat curing. It discusses their design and principle of heat distribution and lists 18 reasons why these heaters are recommended for open space heating. Includes specifications, capacity and dimension tables, sketches illustrating operating principles and construction details and photographs showing the heaters in use. Dravo Corp.

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212 **Fan Heater Bulletin**—Here's a 2-pp illustrated bulletin (No. 109) on a new high pressure steam fan heater designed for complete utilization of both sensible and latent heat of high pressure steam. One page is devoted to description and photos of the heater. Other page contains a sketch in color showing how the heater works. Niagara Blower Co.

213 **Heating Element Data**—Bulletin No. 20, 8 pp, contains detailed capacity and dimension tables on manufacturer's "Paracoil" heating elements. Illustrations and descriptions provide instruction for installation of heating elements and diagrams show six commonly used installation arrangements of hot water generation using these heating elements and storage tanks. Includes conversion table for steam and temperature conditions for determining capacity of any size heating element. Davis Engineering Corp.

214 **Steam Humidifiers**—Bulletin 1771 describes the company's steam humidifiers for automatically controlling relative humidity for the prevention of dry air damage to hygroscopic materials such as paper, leather, wood, cork, foodstuffs and other materials in storage or in process. The bulletin also describes the effect of relative humidity on human comfort and help and explains how maintenance of proper humidity will eliminate the fire and explosion hazards of static electricity where inflammable dust, vapors or liquids are present. Tables and charts are included on desirable relative humidity in various industries. Two useful sections of the bulletin are "How to Select," and "How to Install," both of which are accompanied by excellent line drawings presented in two colors. Armstrong Machine Works.

214A **Packaged Heat**—Unit heaters featuring low first cost, easy installation and continued low cost per Btu are presented in this 12-pp booklet. Text explains how these packaged heaters are designed to operate instantly on oil or gas, fit heat output to requirements of day, and provide heat were it's wanted. Illustrations include photos of heaters and several installations and many sketches showing advantages and construction details. Pratt-Daniel Corp.

215 **Tubular Heat Exchangers**—Bulletin 916 is a particularly informative 32 page bulletin which has "just been issued." The bulletin describes the present designs of the company's tubular heaters, coolers, condensers and heat exchangers and their distinctive features. The various types of shells, tube bundles, stationary heads and floating heads are fully explained, together with statements of the particular services for which each is suitable. An additional helpful feature of the bulletin are tables of the characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and degrees API. Also presented is a chart of the specific heats of midcontinent crude oils and the charts for solving the MTD formula with correction factors for other than countercurrent conditions. The Griscom-Russel Co.

215A **Determination of Steam Quality**—Bulletin 41 is an 8-pp discussion, illustrated with charts and drawings, of procedures for accurate diagnosis of carryover in steam. The design and operation of proper sampling nozzles is explained along with the methods of testing steam quality. Data includes a table of dimensions of sampling nozzles for pressures above atmospheric for use in extra heavy pipes, and graph showing correction factors for ammonia and carbon dioxide in degassed condensed steam. National Aluminate Corp.

TREATMENTS, PREVENTIVES

216 **Protective Coating**—Bulletin 1540, 4 pp, is devoted to a corrosion resistant coating for cold, wet surfaces. Tells its protection against corrosive effects of natural fresh and salt water, cold acid and alkali solutions, acid fumes and atmosphere under shelter. Discusses in detail the use of this coating in water storage tanks and in condensers. Tells how coating should be applied and how to order it. Bulletin also includes photos and description of equipment recommended for use in applying the coating. The Dampney Co. of America.

217 **Corrosion Analysis**—Excellent working data on galvanic corrosion is contained in this 8-pp technical study of corrosion by concentraion cells, reprinted from Inco Corrosion Reporter, Vol. 3, No. 1. Discusses concentration cells, the metal-ion cell type, oxygen cell type, reversible concentration cells, their practical aspects and some rules for minimizing or preventing concentration cell corrosion. Illustrated with sketches showing conditions which accelerate corrosion. The International Nickel Co., Inc.

218 **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in the new 16-pp illustrated Bulletin 28B7030. Describes x-ray diffraction methods employed by the company for identification purposes and the results obtained. Tables list the partial chemical analyses of deposits containing sodium disilicate, occurrence data on compounds found, composition of turbine deposits from turbines operating at various throttle pressures and temperatures, and comparison of compounds found in turbine blade deposits with boiler operating pressures. This is the 10th in manufacturer's series of engineering bulletins. Allis-Chalmers Mfg. Co.

219 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-page technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater systems. Also discusses condensate returns, flushing periods, condenser cooling water treatment and chemical tanks. Illustrations include photographs of two feeders and diagrams of the various methods described. Punched for filing in ring binder. Proportioneers, Inc.

220 **Water Conditioning Bulletin**—This is an eight-page discussion of water and chemicals developed for conditioning

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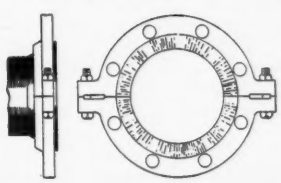

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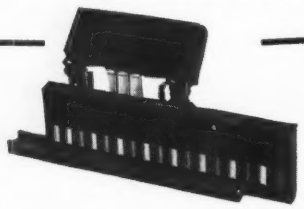

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it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Also discusses special purpose chemicals. Wright Chemical Corp.

221 **Antifoaming Compound**—This new technical bulletin covers the company's latest product known as Antifoam 8. With the accelerated rate of operation in many power plants today, foaming from either chemical or mechanical origin has become one of the prime problems in boiler operations. This technical bulletin presents reasons for foaming and deals with the chemical causes, especially the application of antifoams to elimination of carryover from these causes. After discussing the causes for foaming the bulletin goes on to describe the proper dosage and feeding and results obtained from the use of Antifoam 8. E. F. Drew & Co., Inc.

222 **Corrosion Resistance of Nickel Alloys**—Technical Bulletin T-3 contains 44-pp of illustrated information on the resistance of high nickel alloys to corrosion by sulfuric acid. Although technical in nature, it is written so as to be readily understood by non-technical staffs. Performance of 30 nickel-bearing materials in a wide range of service is discussed, and there are 86 tables and 33 graphs and photos in addition to text. Problems involving a wide range of operations from the pickling of steel to petroleum refining and textile processing are covered. The International Nickel Co., Inc.

223 **Cleaning Industrial Equipment**—This is a general information bulletin on manufacturer's service for cleaning steam generating, heat exchange and other industrial equipment. Also included is information on pipe line cleaning and water well acidizing. Illustrations of these services are included, and bulletin treats in detail the methods used to remove incrustations from internal surfaces economically with minimum of downtime. Dowell Inc.

224 **Anti-Foam Treatment** — This 4-pp bulletin covers a new formula in powder form to be applied along with anti-scale treatment for improving steam quality, controlling scale in boiler feed system and sludge conditioning. It discusses the problem of steam contamination and explains the action of this polyamide anti-foam treatment. Tells how it should be applied and gives dosage requirements. A discussion of its advantages is accompanied by photos showing the effect of polyamide action on a boiling dilute Nacconol solution. Dearborn Chemical Co.

225 **Boiler Corrosion**—A 12 page article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. Numerous illustrations, graphs and tables aid in understanding the article. W. H. & L. D. Betz.

226 **Application Data Bulletin** — Titled "The Aroclors," chlorinated biphenyl and chlorinated poly-phenyls, this booklet describes the unique properties which enables this material to fulfill certain requirements. The Aroclors have won a place in the electrical insulating field and in such widely differing applications as non-flammable hydraulic media, high-temperature and high-pressure lubricants, heat-transfer and expansion media, sealing compounds, adhesives and protective coatings, including plastics, pigments, lacquers, paints and varnishes. This booklet contains 28 pages and presents the combined information gathered by the company from what it believes it to be reliable and dependable sources. Monsanto Chemical Co.

ELECTRICAL

227 **Electrical Diagram Guide**—The purpose and use of electrical diagrams supplied with switchgear equipment are explained in Bulletin GET 1293A. It was written to help those who install, operate or maintain switchgear equipment make the best use of the diagrams that come with such equipment. Discusses in detail one-line, elementary, connection and interconnection diagrams. It tells their scope and uses and illustrates symbols used and common variations and explains ASA device function numbers and conventions. General Electric Co.

228 **Transformer Buyers Guide**—An excellent technical manual on instrument transformers is this 80-page catalog,

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GEA-4626B. Contains descriptions, photographs and index of ratings and construction for indoor and outdoor potential transformers, indoor and outdoor current transformers, outdoor metering outfits and portable potential and current transformers, according to cycles. Dimensions, prices and shipping weights are included with listing of each type, as is reference to manufacturer's bulletin dealing with that type of transformer. Index of types shows voltage and frequencies. Also included are tables showing mechanical and thermal limits of current transformers. Book has firm covers and ring binding for long-time reference use. General Electric Co.

229 **Induction Motor Bulletin**—A four-page illustrated folder, PB 7000-1, describes manufacturer's new two-pole, 200 to 3500 hp induction motor of fabricated steel construction, available in enclosed or separately ventilated types. Construction features are discussed in detail and illustrated with photographs. Elliott Co.

230 **Synchronous Generators**—This Bulletin, 05B6139A, describes construction features and electrical characteristics of engine-type synchronous generators in standard ratings from 25 to 10,000 kva and for standard speeds from 100 to 600 rpm, for Diesel, steam or gas engines. Also describes and illustrates mechanical construction of stators and rotors and discusses machine characteristics, ratings, voltages, frequencies, phases, temperature rises and operation at high elevation. Illustrations show typical installations. Available control accessories are listed, as are manufacturer's other products and territorial sales offices. Allis-Chalmers Manufacturing Co.

231 **Induction Motors**—Twelve-pp Bulletin GEA 3580D covers induction motors, the open, dripproof type, 1 to 2000 hp. Cites performance records of several of these motors, and explains and illustrates construction features. Stresses the easy installation and maintenance and smooth operation of the motors. Contains photos of several of them in use. Apparatus Dept., General Electric Co.

PUMPS, COMPRESSORS, ENGINES

232 **Condensers**—Bulletin 441-C, 28-pp, covers in detail every phase of manufacturer's line of condensers—their simplicity of design, accessibility, construction features. Illustrated with photos and drawings showing complete assemblies, parts, principles of operation. Bulletin also discusses emergency replacements, service and maintenance facilities available, and auxiliary equipment. Includes condenser tube data, pressure-conversion tables. Condenser Service & Engineering Co.

233 **Chemical and High Pressure Pumps**—Catalog 146, 30 pp, covers controlled volume pumps for chemical and high pressure service. Discusses their general applications, tells how they work, and explains manual stroke adjustment and automatic control. Contains photos and descriptions of these pumps in a wide range of capacities. Technical data includes capacity pressure selection tables, a three-color table showing materials of construction suitable for handling more than 175 chemicals. Also gives dimensions, shipping weights and provides a prepared form for requesting quotations. Milton Roy Co.

234 **Compressor Selection Chart**—Here's a new selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Chart covers two letter-size pages. Worthington Pump and Machinery Corp.

235 **Air Compressor Lubrication Manual**—Valuable information on air compressor maintenance is contained in this 40-page book on the lubrication of air compressors, second edition. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements operating hints, oil requirements, storage and care of compressor oils, and safety precautions. All discussions are illustrated with large, clear photographs and drawings showing construction and operation of compressors, their lubricating systems, etc. Cities Service Oil Co. (In the South, Arkansas Fuel Oil Co.)

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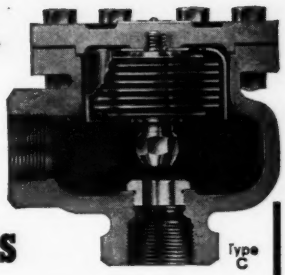

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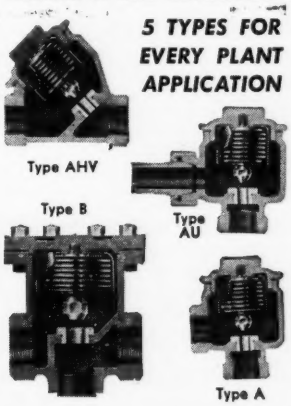

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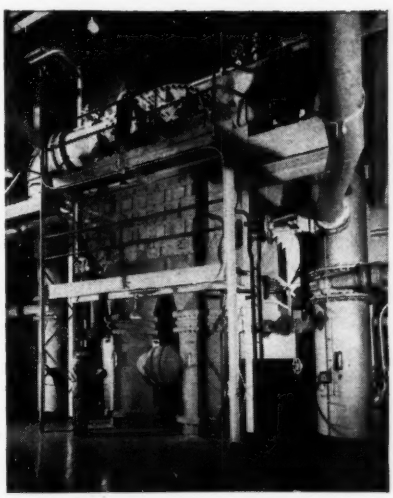

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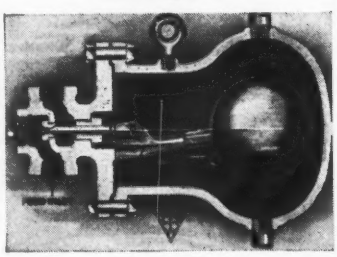

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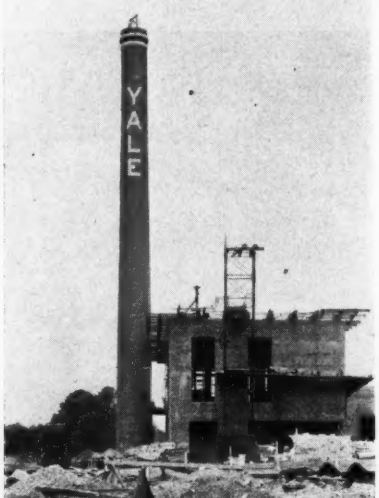

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235A **Steam Pumps**—This is manufacturer's collection of bulletins covering all types of centrifugal and reciprocating pumps for a wide range of industrial uses. Contains more than 80 pp in all and includes photos, dimensions, specifications, ratings and application data. Warren Steam Pump Co.

236 **Steam Engine Governor Data**—This new bulletin No. 502, describes the company's Type EN fully enclosed self-lubricated governor which is described as giving "precise, dependable engine speed control." Illustrations of the unit are presented and a parts list, accompanied by a sectional diagram is given. One section "Installation and Care" tells how to assemble governor to engine cylinder and how pulleys should be proportioned, the proper type of belt for use with the governor, correct lubrication procedure, method of packing and other data. Troy Engine & Machine Co.

237 **Turbine Catalog Collection**—This is a valuable collection of bulletins in loose-leaf form. They cover a complete description of manufacturer's solid wheel turbines and feature cross section drawings of typical units for both moderate and high steam pressure conditions. Also provides a description of an axial flow impulse, both single and multi-stage, and complete data on speed increasing and speed reduction gears. The Terry Steam Turbine Co.

237A **Velocity Stage Turbines**—Catalog 82-19R, 8 pp, features turbines for mechanical drives designed to operate under all inlet steam conditions up to 600 psig and 750 F. Gives complete specifications, dimensions and includes chart showing how to estimate turbine sizes. Illustrations include cutaway view, photos of parts. Speed governor and regulating valve, and emergency governor and trip valve are described in detail. De Laval Steam Turbine Co.

INSTRUMENTS AND CONTROLS

238 **Combustion Instrument Catalog**—Twelve-pp Condensed Catalog 49-687 describes briefly and illustrates instruments and controllers for both boiler rooms and industrial processes. Equipment covered includes automatic controllers, meters for indicating content of flue gases, draft gages, flow meters, gas analyzers and recorders, and combustion testing equipment. The Hays Corp.

239 **Water Gages** — Eight-page Bulletin E-1 covers line of water gages for stationary and locomotive boilers, marine and refinery service and tanks for all pressures and temperatures. Listings include photos of all gages, sizes and construction details. Bulletin S-2, four pages, covers gage glasses, glass guards, sight flow indicators and related equipment. Ernst Water Column & Gage Co.

240 **Temperature Measuring Instruments**—For all those responsible for the safe operation of electric power equipment, this company has just issued a revised 34 page catalog ND4-33-461 describing the company's instruments for measuring the temperature of generators, motors, condensers, transformers, etc. The bulletin covers a wide variety of instruments, portable and automatic indicators, for checking in any order on temperatures. Reference also is made of new and specialized instruments for measuring in rapid succession a number of bearing temperatures. Leeds & Northrup Co.

241 **Combustion Control**—Bulletin 102-D describes this company's air operated combustion control. Containing 32 pages and bound in a heavy paper cover, the booklet describes completely the application to boilers fired with oil burners, stokers, to furnace draft control and points out its adaptability to any plant layout. Descriptions of the controllers themselves along with integral parts of the units are given. Typical installations of pulverized coal fired boilers are presented in a separate section of the bulletin. Installations on stoker fired boilers and on oil fired units also are given. Bailey Meter Company.

242 **Boiler Water Level Control** — Bulletin 487 describes completely the installation of boiler water level control equipment at the Blackhawk Generating Station, Wisconsin Power & Light Company. Photographs of the installation are presented as is a schematic layout of the entire station along with tabulated significant data. A large, full-page cross section of the B & W Type FH integral furnace boiler is presented and other drawings and photographs show the accompanying equipment. Northern Equipment Company.

243 **Multiple Signal and Alarm Systems** —Panalarms, multiple signal and alarm systems adaptable to all types of industrial and power plant applications, are described in 12-page, letter-size, illustrated Series 300 Panalarm bulletin. Gives details of operation, shows types for panel and well mounting, wiring circuits, operation sequence, dimensions of units. Shows how Panalarms indicate by light and horn signals, acknowledging button, for normal and abnormal conditions. Systems are supplied in multiple units up to 12 in single cabinet; extra space for spare units; provisions for future additions; simple field wiring. Price list included. Panalarm Products, Inc.

244 **Instrument Handbook**—"Modern pH and Chlorine Control" is a 100-pp catalog containing a great deal of valuable information in addition to covering manufacturer's line of scientific instruments and accessories. It explains the meaning of pH control, the electrometric and colorimetric methods of determining pH, and gives values of common acids, bases and foods, as well as maximum capacities of buffer systems. It also discusses in detail the applications of pH and chlorine control in air conditioning, water treatment, boiler water and many other industrial applications, recommending instruments and solutions. Instruments are illustrated by photograph, their functions described and sizes and prices given. W. A. Taylor & Co.

DUST COLLECTING

245 **Dust Collectors** — Dust collecting equipment for power plants, foundries, cement plants and similar industries is the subject of Bulletin No. 1428, 26 pp. Contains many photographs of installations, also photos showing equipment being tested in company laboratories. Discusses services offered by manufacturer in analyzing individual installation requirements and recommending equipment for the job. American Blower Corp.

246 **Filter Catalog**—Manufacturer's line of filters for air and other gases, liquids, chemicals and special applications is presented in 44-pp Form 450. Its pictorial index is followed by a brief discussion of the applications of pipeline filters, air intake filters, liquid filters and ventilation and air conditioning filters. Each type illustrated and described in detail. Capacities, specifications, sizes given. Includes layout drawings, a listing of some of the filtering media available, installation data on panel filters, and selection chart for dry type filters. Dollinger Corp.

MATERIALS HANDLING

247 **Continuous Weighing of Dry Materials**—Bulletin E4-550 describes the company's new meter for continuously weighing and totalizing the flow of dry materials on conveyor belts. The meter can also be used for the automatic proportioning and controlling of dry or liquid feeders for secondary ingredients. The bulletin describes how the device operates, how it is constructed and gives various features. A double page spread, printed in two colors, presents a typical installation of the unit on a belt conveyor. Blueprint type drawings illustrate various applications for the continuous weighing and/or controlling and proportioning and flow of dry or liquid materials. Builders-Providence, Inc.

248 **Dry Materials Conveyor** — Bulletin F-H-1 describes this company's revolutionary type of conveyor designed for the handling of fine, dry materials. The book, which contains 12 pages, presents excellent installation views of the conveyor, and also drawings which illustrate construction and method of operation. The bulletin points out that the conveyor has no moving parts and that it has no hazards to workmen, is silent in operation, requires no lubrication and can pass around obstacles. Fuller Company.

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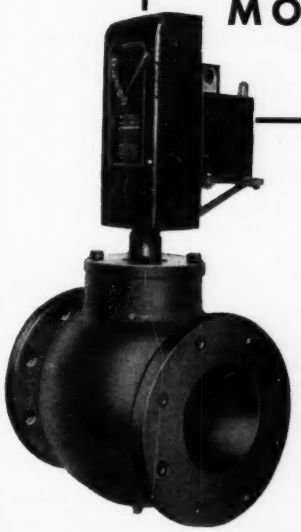

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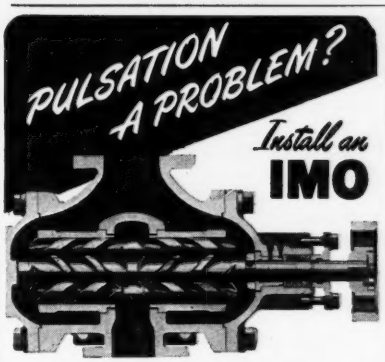

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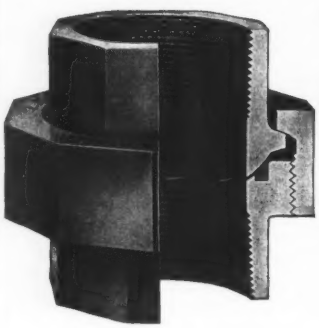

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248A **Coal Scale Data Book**—The answers to a power engineer's questions on coal scales are provided in this excellent 48-pp book, Bulletin 1143, covering scales for recording weight of coal consumed by individual boilers and weight of coal receipts from ship, car, truck or storage. It is generously illustrated with photographs of models and accessories and actual plant installations and contains all necessary engineering drawings, dimensional data and detailed specifications. Construction features and operation of weighing and feeding systems are described. Richardson Scale Co.

MISCELLANEOUS

249 **Pump Packings**—Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes a table of recommendations to facilitate selecting the right packing for any particular application. Johns-Manville.

250 **Industrial Insulation Catalog**—Mineral insulations for practically every purpose are covered in this 20-pp illustrated catalog. It describes in detail insulating cements for both high and low temperatures, high temperature block insulation, block finishes, felts, blanket insulation, pipe coverings, loose wool, weatherproofing and stack paints. Includes information and what each class of insulation is for, what it can be expected to do, how it's applied, how it's packaged and, in most cases, how much it costs. Discusses requirements of a good insulation and tells how these products meet the requirements. Forty-Eight Insulations, Inc.

251 **Cooling Towers**—Double-flow cooling towers are featured in 20-pp Bulletin DF. It discusses the principle of double-flow cooling, the mechanical equipment utilized, construction features of a tower of this type, water distribution, coil shed, and safety factors. Recommends sizes for different applications and includes photos of many installations. The Marley Co., Inc.

252 **Concrete Floors Q & A** — A new booklet titled Lumnite Concrete Floors—Corrosion Resistant and Heat Resistant, has just been published. The detailed information contained in this booklet brings up to date, the service experiences and late developments in this field. The information covers methods and materials used in placing corrosion resistant concrete in a wide variety of industrial applications. Typical uses of corrosion resistant concrete are listed for many industries and also given, are the answers to a number of questions often asked about it. A section on placing and finishing corrosion resistant floors will be helpful to prospective users. Lumnite Division, Universal Atlas Cement Company.

CRUSHERS

253 **Coal Crushing, Sizing** — Bulletin 3007 describes the company's Bradford breaker a coal crusher, sizer and scavenger. The bulletin presents drawings of the breaker, tells how it works and then presents the complete story of its operation at the coal mine and coal cleaning plant at the By-Product Coke Plant and at the Power Station. The back section of the catalog presents engineering information on capacities, dimensions and dimensioned line drawings. Pennsylvania Crusher Company.

254 **Coal Crusher**—In this 8-pp bulletin a rolling ring crusher is presented as a solution to the problem of uniform stoker coal. Describes the special features of this crusher, emphasizing its shredder designed to split coal rather than crush it. Gives speed, capacity, weight and dimensions of available models and illustrates principle of operation. Also contains photos of parts and several complete installations. American Pulverizer Co

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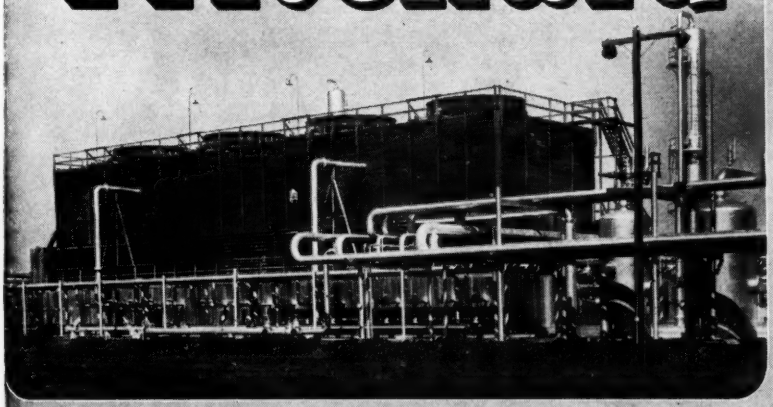

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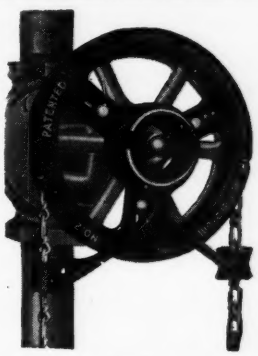

Range of 10 adjustable sizes takes care of all valve makes and types; fits valve wheel diameters from 2 to 30 inches.

HELP!

FOR EVERYONE WHO HANDLES VALVES OR PIPING

Babbitt *Adjustable* SPROCKET RIM *with Chain Guide*

Control overhead valves with ease and certainty, no matter how high up — right from the floor! No more climbing on bench, machine, boiler, treacherous stepladder. For overhead pipe layouts, plan on putting valves wherever needed. The BABBITT Adjustable sprocket Rim with Chain Guide is especially designed for easy, positive control of those out-of-reach valves — from the floor.

The BABBITT Rim fits all valves, with either rising or non-rising stems. It is installed quickly by clamping onto the hand wheel of the valve.

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Always

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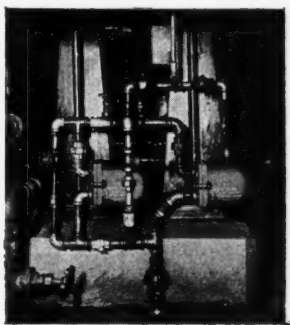
You soon find that exact temperatures and smooth working heating or cooling costs less—in fuel, in metered water and in increased trouble-free production. Only a few examples are shown on this page. Invariably the whole investment is saved in a few months.



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Water is bound to collect in air lines. Sarco removes it at the compressors, the after coolers, on the lines and at the point of use. This manufacturer says "Sarco spelled the end of a perfect nuisance." Ask for Bulletin No. 450.

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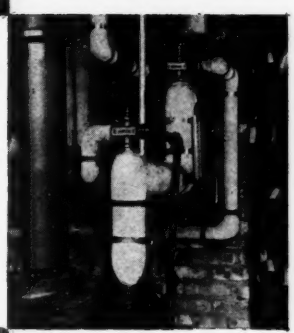
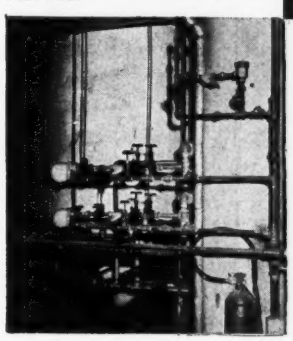
This inexpensive Sarco TR-40 Cooling Control increased the efficiency and prevented service break downs due to overheating of a large compressor. Less water used and the warm water used in an adjacent building. Bulletin No. 700.





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are often outdoors. The advantages of the No. 9 and 87 steam traps are that: (1) they don't freeze; (2) they utilize sensible heat.

The 87 also provides an approximate temperature control.

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IMPROVES PRODUCT QUALITY AND OUTPUT

NEW ENGINEERING BOOKS

(Continued from page 114)

operations of the Douglas Dam and reservoir on the French Broad River are discussed by the TVA in this book. Although constructed on an emergency basis and operated primarily for power during World War II, Douglas forms an integral unit in the over-all system of water control projects in the Tennessee Valley.

The publication covers in detail preliminary investigations for the project, including: geology; river flow; dam and power-house design; construction methods; including construction plant, river diversion, and access routes to the dam site; relocation and adjustments made necessary by creation of the reservoir; initial operations; and a complete summary of the project costs. The appendixes include a complete statistical summary of physical features of the project; reports of engineering and geologic consultants; summaries of special studies, such as hydraulic model studies; and lists of major purchases and construction equipment. Bibliographies on each phase of the project are also included.

This report is one of the series on the various projects of the TVA including those on Norris, Wheeler, Pickwick Landing, Guntersville, Chickamauga and others previously noted in these columns. All these reports, except for two or three that are now out of print, are available from the TVA treasurer. They present not only the most complete engineering and technical data on every phase of each project but also a complete detailed breakdown of costs.

• • •

DeLaval Engineering Handbook, 2nd Edition; by the Engineering Staff of the DeLaval Steam Turbine Co.; edited by Austin H. Church and Hans Gartmann; illustrated; size 5½ by 8 in.; cloth binding; published by the DeLaval Steam Turbine Co., Trenton 2, N. J. Price $2.00.

The first edition of this handbook was so well received throughout the industry that the second edition has now been necessary. This revision has had careful attention based on the first edition.

The handbook is intended to make easier the work of power plant, industrial and design engineers. The book is divided into six main sections; namely: 1—mathematical, mechanical and fluid information of a general nature; 2—Steam turbine data; 3—Centrifugal pump data; 4—IMO pump data; 5—Compressor, blower and exhauster data; 6—Helical reduction gear data; and 7—Worm reduction gear data. The book is filled with very practical and usable charts and tables, with the necessary explanations, inserted where needed.

• • •

Dynamic Equipment Policy, by George Terborgh; 290 pages; 6 by 9 in.; cloth binding; published by McGraw-Hill Book Co., 330 W. 42nd Street, New York. Price $3.75.

Equipment policy, says the author, is the most backward area of industrial management today. Not only do many companies lack an effective organization for bringing profitable re-equipment opportunities to the attention of management, he says, but in most cases the deciding executives have no adequate method for analyzing the merits of the proposals submitted.

This book was written, therefore, to help meet an important management need and develop the basic principles of sound re-equipment analysis and discuss practical procedures for their application. Numerous examples from actual experience are included; and then, in the light of these principles and procedures, the book evaluates the more popular devices and rules of thumb now in use, showing the errors and frequent absurdities to which they lead.

The fundamental problem of prediction in ownership replacement is considered, also the necessity of making assumptions about the future when prediction is impracticable. Two standard assumptions are explored and the book then turns to their application. Mathematical short cuts are derived and tested for reliability and the practical problem of applying these short cuts is analyzed. The book concludes with a criticism of some of the replacement formulas now in use, with the questions of the organization of equipment policy and finally considers the importance of a dynamic policy for the individual business and for the economy as a whole. Many tables of specific data and graphs of relations are presented and the book is well indexed.

The author is Director of Research of the Machinery and Allied Products Institute, and has contributed such outstanding works as "An Appraisal of the Fatalistic View of Capitalism," "The Bogey of Economic Maturity," "Depreciation and Postwar Profits," and "Technological Stagnation in Great Britain."

• • •

The Most Desirable Personal Characteristics. Size 6 by 9 in.; 25 pp; paper bound. Published by the Engineers' Council for Professional Development, 29 West 39th Street, New York 18, N. Y. Price $0.25.

A study of almost universal interest, but presented in a rather confusing manner. It presents the data of a 3 yr survey to provide facts about human personality valuable in professional development. Intelligence in this study was rated first, dependability second, organizational adaptability third, energy is fourth, and emotional or physical acceptability as fifth and sixth.

Returns from engineering school administrators, faculty, personnel advisors, students and industrial executive groups agreed remarkably well although there was considerable difference in the desirable characteristics for such diversified groups as general engineering, research, engineering design, production, sales and distribution.

Perhaps this reviewer's confusion in deciphering the conclusions of the study arises from the subject itself. Little has been done in approaching it from this point of view, as the authors readily admit. It is a first groping attempt to evaluate some very intangible factors.

• • •

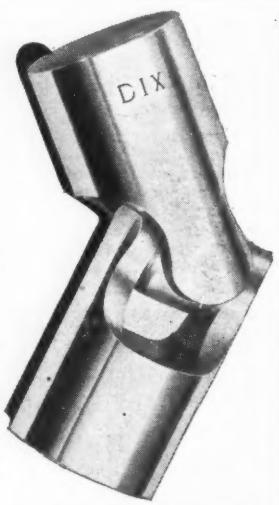
Typical Designs of Timber Structures. Size 13½ by 8½ in.; 106 pp plus index; paper bound. Published by the Timber Engineering Co., 1319-18th St., N. W., Washington 6, D. C. Price $10.00.

A practical manual for the use of engineers and architects showing in detail designs developed by the company and its lumber associates during the past 15 yr. The plates show, usually on a ¾ or 1 in. to the foot scale, detailed drawings of various trussed rafters, roof trusses, factory construction, bridge and trestle, warehouse, tower and hangar design. Practically everything that will be encountered in the usual industrial design practice is included. In general the plates show detailed drawings, photographs of typical designs and a bill of material.

PRECISION—

as well as finest alloy steel account for the unequalled Strength, Durability, Dependability and *economy* of

DIX UNIVERSAL JOINTS



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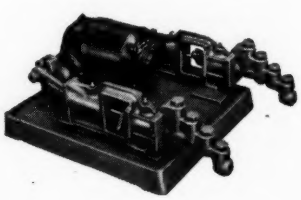
Select Milton Roy Pumps for the above applications . . . pumps that are non-clogging and self-cleaning . . . positive displacement, precise metering units that handle everything from slurries and solids in suspension to the lightest solvents, hot or cold . . . pumps with liquid ends to meet practically every corrosion resistant problem and to pump up to 20 thousand psi for high pressure catalysis and hydrostatic testing.



Investigate. Ask for Catalog 146.

MILTON Roy COMPANY

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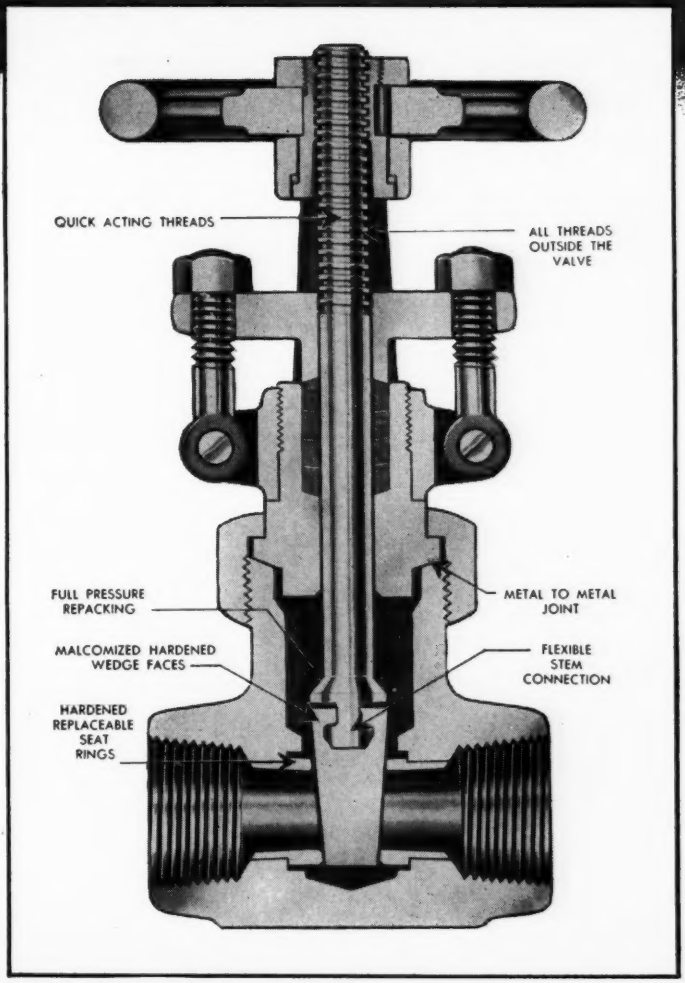
You Can Repack this CHAPMAN LIST 960 UNDER FULL PRESSURE

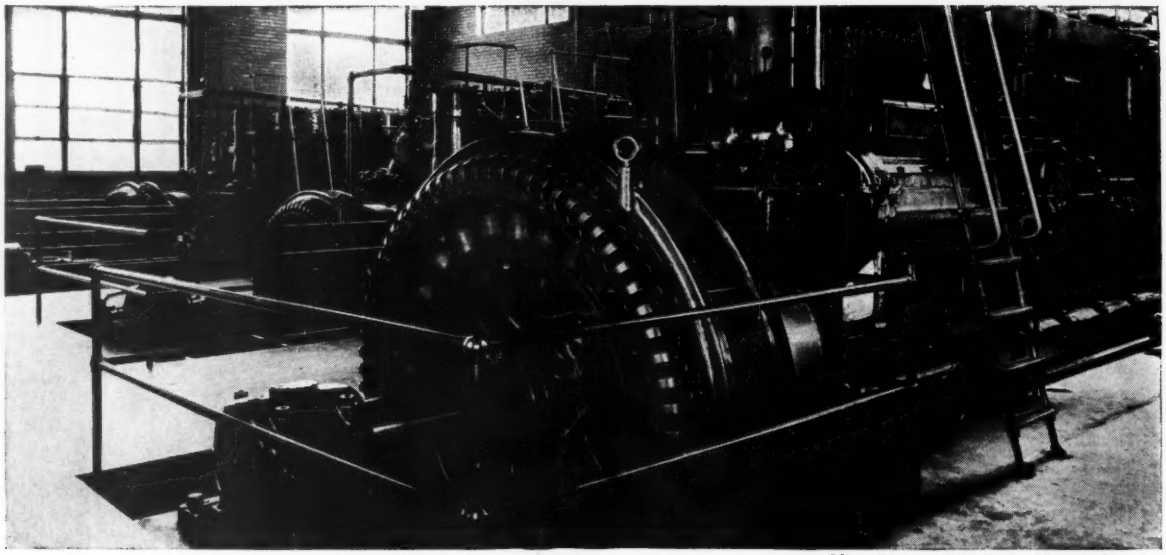
Here's a rugged, small gate valve you can repack right while it's in use . . . no pressure is transmitted to the stem. Use it in exposed locations, too, for a forged steel packing gland protects the vital yoke threads against rust and corrosion. A recent design feature gives stem and wedge gate connection a more than 50% increase in strength . . . extra protection against even the most extreme operating conditions.

Made in sizes from ¼" to 2"—carbon steel for pressure range 2000 pounds at 100° F., 380 pounds at 1000° F. For higher pressures, specify List 990.



The Chapman Valve Manufacturing Co.
INDIAN ORCHARD, MASS.

IN 14 YEARS NO STUCK RINGS*



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THE case illustrated is typical. Operators everywhere find that *Texaco Ursa Oils* give them year-in-year-out high Diesel efficiency... lower maintenance costs ... reduction in fuel consumption.

Texaco Ursa Oils are especially made for Diesel lubrication. That means superior resistance to oxidation ... ability to stand up under high temperatures ... freedom from carbon, sludge and varnish. *Texaco Ursa Oils* assure better compression and combustion ... longer life for bearings, pistons, rings and cylinder liners.

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More stationary Diesel hp. in the U. S. is lubricated with Texaco Ursa Oils than with any other brand.

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TEXACO

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